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The Aviation System Analysis Capability Noise Impact Model

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July 1999

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Contents

FIGURES

TABLES

The Aviation System Analysis Capability Noise Impact Model

SUMMARY

The primary purpose of the ASAC Noise Impact Model (NIM) is to enable users to examine the impact that quieter aircraft technologies and/or operations might have on community noise impact and on air carrier operating efficiency at any of 16 large- and medium-sized U.S. airports, as well as, one European airport. These are Atlanta (ATL), Boston (BOS), Cincinnati (CVG), Dallas-Ft. Worth (DFW), Detroit (DTW), Newark (EWR), Washington-Dulles (IAD), New York-Kennedy (JFK), Los Angeles (LAX), New York-La Guardia (LGA), Orlando (MCO), Minneapolis (MSP), Chicago-O'Hare (ORD), Pittsburgh (PIT), Seattle (SEA), San Francisco (SFO), and Zurich (ZRH).

To use the NIM, an analyst selects an airport and case year for study, chooses a runway use configuration and set of flight tracks for the case, and has the option of reducing noise of the aircraft that operate at the airport by 0-40 decibels. A default annual-average runway use pattern is available for each airport. This is the current existing configuration and may incorporate preferential runway use patterns due to community noise restrictions. For some airports, NIM provides, as an alternative scenario, a more efficient runway use configuration that could be used if noise were not an issue. Alternate runway use patterns, capacity, and delay values are available for three airports: Los Angeles International (LAX), Chicago's O'Hare International (ORD), and San Francisco International (SFO). Likewise, two sets of flight tracks are available for 11 airports: one that represents current conditions, including noise abatement tracks, which avoid flying over noise-sensitive areas; and a second set that offers more efficient routing in or out of the terminal area. The remaining five airports do not use noise abatement tracks, so no alternate flight tracks are provided for DFW, DTW, IAD, ORD, and PIT.

NIM computes the resultant noise impact and, for some airports, reports the change in airfield capacity and delay associated with the efficient runway use configuration, and reports the time and distance saved from using the more efficient, alternate flight tracks. The relationship between runway use patterns and airport capacity is a new capability with this release of NIM. Previously, the capability to analyze flight tracks was provided through the stand-alone Flight Track Noise Impact Model (FTNIM). Both functions are now combined and use the same noise and impact calculation algorithms.

Noise impact is characterized in three ways: the size of the off-airport noise contour footprint, the number of people living within the various contours, and the number of homes located in the same contours. The change in airfield capacity is estimated by comparing the difference in the number of peak hourly arrivals and departures for the noise abatement pattern with the more efficient runway use configuration. Delay is estimated as a function of capacity and demand. Flight track time and distance savings are calculated by comparing the noise abatement flight path length to the more efficient alternate routing.

The current version of NIM is designed for World Wide Web implementation. Access is through the ASAC home page (http://www.asac.lmi.org). WorldWide Web HTML screens are used for all input, case processing, and output. These NIM core input screens, are used to define the parameters for a single airport case. scenario file. Then the NIM on an NT Server processes the inputs, compute noise impacts, and displays the results in an output text table, and also graphically in a jpeg file. The model is designed to be simple to run; a single airport scenario may take from 5 minutes to an hour, depending on the complexity of the case.

Noise calculations are performed using the core modules of the FAA's Integrated Noise Model (INM) Version 4.11. Population and housing counts are computed using an algorithm that incorporates 1990 census data, modified to account for population growth and nonresidential areas such as the airport property and nearby water bodies. The geographic information system is built on MapInfo Pro-Server, a commercially available mapping software package for network applications.

We recognize that modifying runway usage patterns or relocating aircraft flight patterns are technically and politically sensitive issues. This model is intended as a simple analysis tool and does not presume to offer prescriptions for actual airfield operation. Some airports and airlines have suggested that operational changes may be possible in certain circumstances. However, existing noise mitigation programs at most airports cannot be modified without further technical review and open public involvement. The options included in NIM provide important insights into the relationship between noise abatement and airline efficiency to guide research, not public policy.

INTRODUCTION

This introduction reviews our past research into the relationship between noise abatement and airline efficiency is highlighted, describing the proposed uses for the ASAC Noise Impact Model (NIM). The second section describes, in general, terms how the model works. The third section provides a more thorough report of the program's flow and methodology. The fourth section presents a sample case. Then, the final section offers conclusions.

NIM Background and Purpose

During 1994, the Logistics Management Institute (LMI) initiated a NASA-sponsored study to analyze the economic impacts of local noise restrictions on air carrier operations. The project goals included documenting which noise abatement measures have the most impact on the way airlines operate and assessing the potential economic value of quieter aircraft technologies. Results of this study are documented in a LMI research report (WR 96-19) entitled "Aircraft Noise Reduction and Air Carrier Efficiency."

Since that initial study, LMI, with oversight from NASA Langley Research Center, expanded the scope of work and began developing a noise impact model to be integrated into ASAC. This model is intended to help users examine the effects that new aircraft technology may have on the aviation industry.

The first generation noise impact model, the Flight Track Noise Impact Model (FTNIM), was released in early 1997 as a stand-alone computer program. This model examined the combined effects of quieter aircraft and more efficient flight tracks at eight U.S. airports. This version is described in the NASA Contractor Report (201683) entitled *The Flight Track Noise Impact Model.*

Work under the current task has developed a tool that NASA researchers and others can use to examine how runway use patterns are related to airline operating efficiency and community noise impact. We developed the capability to examine the relationship between more efficient runway usage and community noise impact. This concept, the Runway Use Noise Impact Model (RUNIM), has now been combined with FTNIM. The new merged version is called, simply, the ASAC NIM and will be hosted on the World Wide Web. In addition to incorporating the runway use model for three airports, the scope of the FTNIM analysis capability has been expanded to a total of 16 large- and medium-sized U.S. airports and one foreign airport.

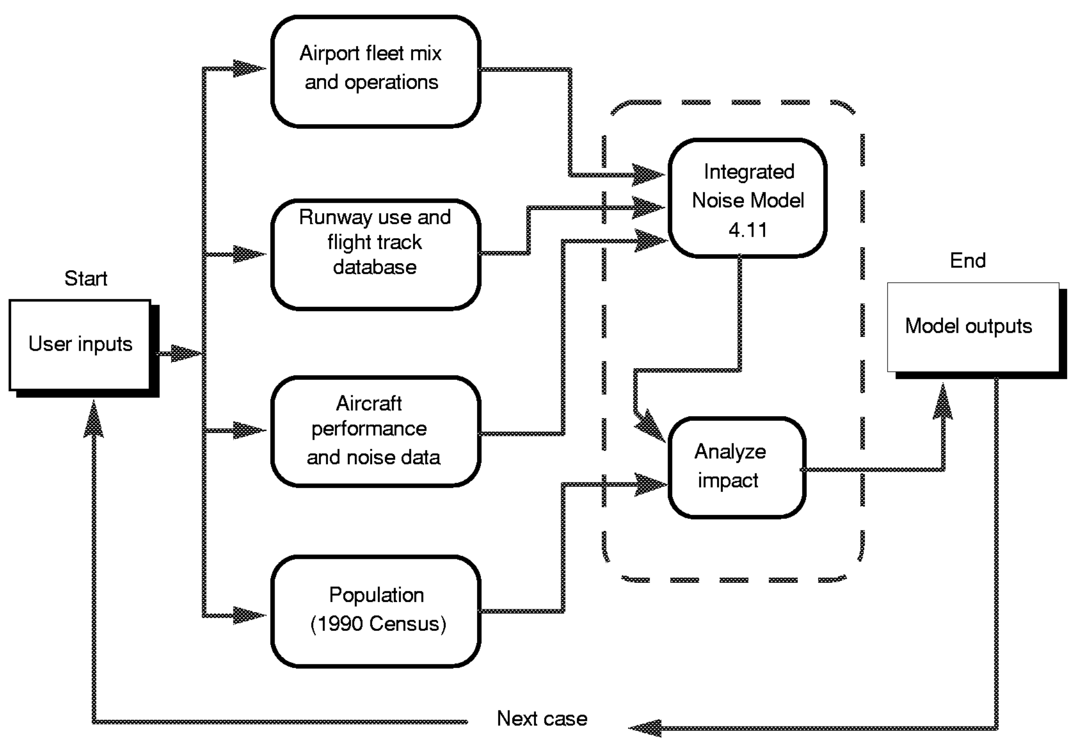
Anticipated Use of the Noise Model

Using NIM, an analyst can ask "How could airline operating efficiency be improved if noise were not a problem at this airport?" To facilitate this analysis, NIM provides a baseline set of noise abatement procedures at 16 airports, enables the user to model quieter aircraft, offers alternative runway use patterns and flight tracks for a subset of these 16 airports, and assesses the community noise impact that results when the quieter airplanes use the alternate procedures. By exercising NIM for successive cases, analysts can determine the reduction in the magnitude of the noise source from one or more specific aircraft types required to hold the community noise impact constant, or even reduce it, while simultaneously improving airline operating efficiency.

OVERVIEW OF MODEL CAPABILITIES AND ACTIONS

The NIM accesses a collection of databases, gathers and processes the information needed to analyze a user's case, executes two distinct computational actions, and documents the results along with a case history. Each of these functions—database access, case development, computation, and results output—are outlined below and are depicted in Figure 1.

Figure 1. Noise Impact Model Flowchart



Database Access

NIM operates on five types of data derived from the sources noted in the Table 1.

Table 1. Data Types and Sources

Data type	Source
Airport fleet mix and operations	LMI – ASAC
Airport operations analysis	LMI
Runway use database	LMI
Flight track database	LMI
Aircraft performance and noise data	FAA – Integrated Noise Model
Population and housing	1990 U.S. Census

Case Development

To develop a scenario, the user chooses one of the three case years for which operations data are available (1993, 2005, or 2015) and selects one of the following 17 airports:

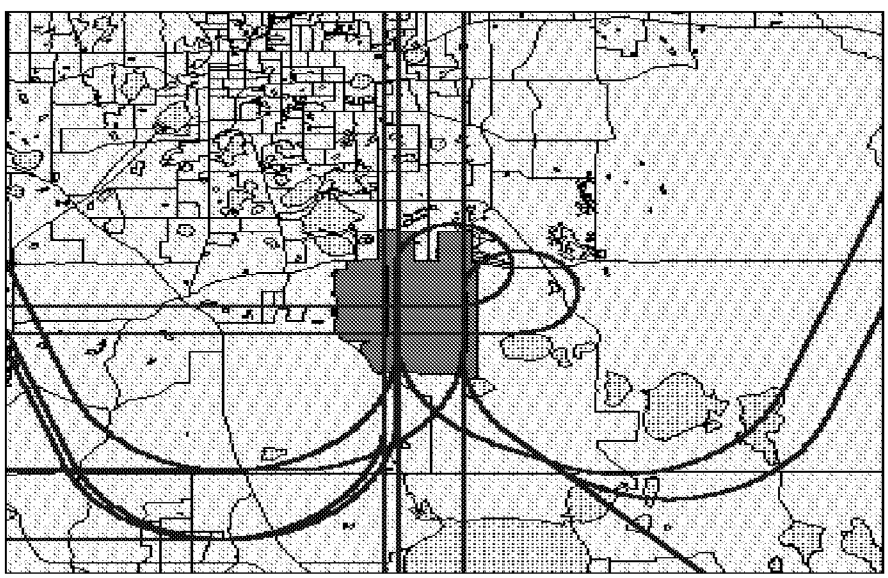
- The William B. Hartsfield Atlanta International Airport (ATL)
- General Edward Lawrence Logan International Airport (BOS)
- Cincinnati/Northern Kentucky International Airport (CVG)
- Dallas-Fort Worth International Airport (DFW)
- Detroit Metropolitan Wayne County Airport (DTW)
- Newark International Airport (EWR)
- Washington Dulles International Airport (IAD)
- John F. Kennedy International Airport (JFK)
- Los Angeles International Airport (LAX)
- La Guardia Airport (LGA)
- Orlando International Airport (MCO)
- Minneapolis-St. Paul International Airport (MSP)
- Chicago-O'Hare International Airport (ORD)
- Greater Pittsburgh International Airport (PIT)

- Seattle-Tacoma International Airport (SEA)
- San Francisco International Airport (SFO).
- Zurich International Airport (ZRH).

Once the airport and case year have been chosen, NIM provides the default runway use configuration and flight tracks, which may include noise abatement procedures. For three airports (LAX, ORD, SFO), users have the option of selecting a more efficient runway use configuration. For eleven airports (ATL, BOS, CVG, EWR, JFK, LAX, LGA, MCO, MSP, SEA, and SFO) a set of flight tracks have been developed excluding community noise impact as a factor.

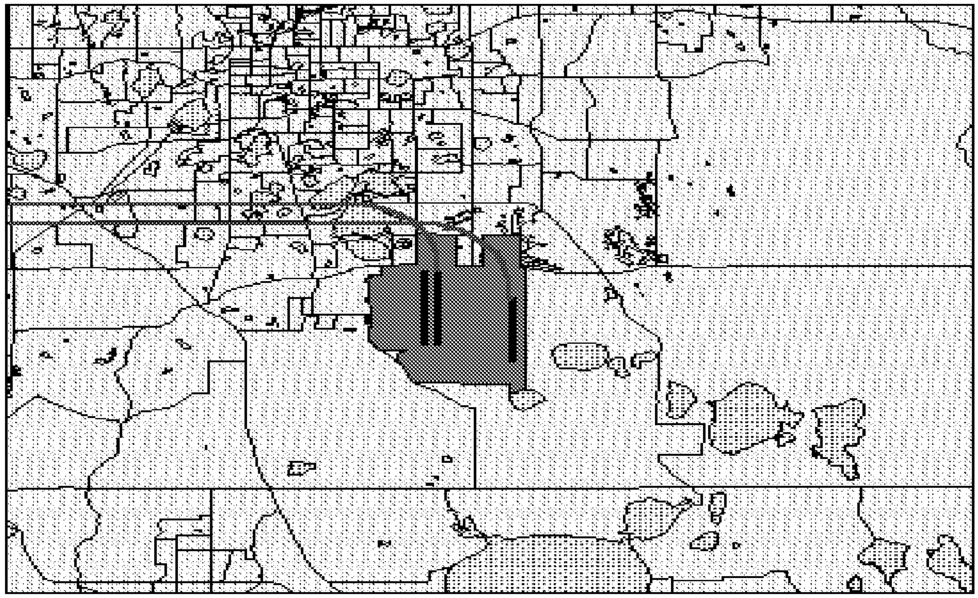
If the runway use configuration is improved, airfield operations become more efficient, potentially improving airfield capacity and reducing delay. If flight tracks are optimized, the existing noise abatement flight tracks are replaced with tracks designed for more direct routing into or out of the terminal area, with associated time and distance savings. The change in airfield capacity and delay, and the time and distance savings from each efficient flight track have been precomputed.

Figure 2. Existing Flight Tracks for Orlando International Airport



Note: Two flight tracks execute a 270 degree turn when departing to the north. This routing avoids flying over the dense residential population of Orlando, immediately north of the airport.

Figure 3. Optimized Flight Tracks for Orlando International Airport



Note: In this figure, the same two departure flight tracks have been relocated to fly over Orlando. This saves time and fuel for the aircraft operator, but would only be acceptable to the community if the aircraft were quiet enough not to create adverse noise impacts.

Figures 2 and 3 demonstrate the concept of using more efficient airfield and flight track operation procedures; shown are existing and optimized flight tracks for Orlando International Airport. Current noise restrictions limit the use of north-flow runway use configurations due to the dense residential population of Orlando, immediately north of the airport. When aircraft are operating to the north, they must execute a time-consuming flight path to avoid over-flying the populated areas.

The introduction of new technology aircraft, with lower noise characteristics, would potentially increase the use of north-flow configurations and improve airfield capacity. While noise is a factor in determining airfield capacity, there are several other important factors, including wind, weather conditions, and airspace management issues. The NIM database of runway use configurations has been developed in cooperation with airport operators to ensure that the assessment of alternate patterns are realistic, given all the other factors that influence airfield operations and capacity.

Scrutiny of flight procedures at most airports reveals that moving flight tracks brings up several airspace management issues. For example, with three large airports sharing the same airspace, the New York Metropolitan Area has a very complex, high-density air traffic environment. A noise abatement flight track at Newark cannot simply be relocated without taking the traffic patterns at La Guardia and Kennedy airports into account. In all cases, we exercised caution in defining alternative routes to ensure that these optimized tracks are realistic in terms of safety, aircraft performance, and air traffic management.

The standard noise abatement and alternate efficient flight tracks for each of the study airports are shown in Appendix A. The time and distance savings estimated for each of the optimized tracks are included in Appendix B.

The numbers of departures for the case airport and year are displayed for four categories of jet-powered commercial aircraft: wide- or narrow-body and short- or long-haul (an equal number of arrivals are assumed). In NIM, a long-haul flight is 1,000 statute miles or more. Figures for each category of aircraft may be increased or decreased at the user's discretion. The number of departures by all other aircraft (i.e., propeller, general aviation, helicopters, and military) will be displayed but may not be changed.

The fleet mix for the facility and year also are displayed, and the user may reduce the modeled noise level for any commercial jet aircraft type by 0-40 decibels (dB). NIM also enables users to reduce the noise level of an entire category of aircraft (wide- or narrow-body) in one step and then go back and selectively modify the noise-reduction factors for individual aircraft types.

Computation

NIM exercises two computational modules as part of the analysis. First, it calls up the FAA's INM to compute the noise impact for the user's scenario. Noise impact is defined with a set of selectable noise contours between 55-85 dB day-night average sound level (DNL). DNL is the industry standard for evaluating noise impact, and it accounts for the number and type of flights as well as the fleet mix and flight tracks. Operations conducted between 10 p.m. and 7 a.m. are assigned a 10 dB penalty to reflect their greater intrusiveness. The noise contours show which areas around the airport experience the greatest noise and the average noise level. The 1993 baseline DNL contours are shown for all study airports in Appendix A.

Second, NIM exercises a geographic information system (GIS) to compare the noise impact areas with the residential neighborhoods and count the number of homes and people within the noise contours. The GIS module also subtracts the airport property and bodies of water from the noise contour areas computed by INM to give an "off-airport" area of impact, in acres.

Results Output

The NIM Core program reports changes in air carrier operating efficiency, including the change in airfield capacity, estimated delay, and the time/distance saved for operations on each optimized flight track along with measures of community noise impact—the number of acres, homes, and people exposed to significant levels of noise from airport activities. These outputs are provided in a tabular format and can be saved along with the case parameters. The NIM Core program, in addition to reporting the outputs listed above, provides a graphic display of the selected DNL 55-85 db contours along with a map of the airport vicinity (including airport boundaries). In addition, another graphical file is also generated with a color coded legend defining each contour. In the SEL case or a case where a flight track has been modified, a third graphical file is generated. This output file shows the actual flight path used or modified.

NIM OPERATION

This section describes NIM components and provides a sample calculation, step-by-step, to explain the modeling methodology.

Model Components

Several distinct components are combined to provide the modeling capabilities available in NIM: the user interfaces, databases, and computational modules. We created the original user interfaces using the C++ programming language. The Web-based implementation may change the form of these interfaces slightly. However, the data being collected, transferred, and reported will remain as described here.

Although much of the database content is taken from external, verified sources and then reformatted for use by the model, some has been developed in-house. The analytical program modules were written in the C programming language. In addition, modules are used from two outside sources: the core noise computation module of the FAA's INM and MapInfo Pro-Server, a geographic information system software package. The various modules are linked through a series of subroutines that process and transfer the data at each stage.

User Interfaces

Analysts use the internet-based NIM input screens to build and process a single airport case and output the results in tabular format. Users are able to download two output files upon model run completion. The first file is a text file with all output data. The second file is the airport contour map, which, is provided in the .jpeg format. The interfaces that the analyst will use depends somewhat upon the type of case being tested. In the following section, we will look at the interfaces used in four possible scenarios. The scenarios are as follows:

1. Building a standard case.

2. Analyzing a single noise event.

3. Adding a new aircraft.

4. Adjusting the Flight Track On-Screen

INTERFACES COMMON TO ALL FUNCTIONS

NIM Description Home Page

Figure D-1 shows the web-based input screen, which is accessible through the ASAC Model Wizard. This screen is the starting place for all runs of the Noise Impact Model. On this page, the user will find a description of the background and functionality of the NIM. All users must start at this page to be assigned an appropriate file name for the scenario that they wish to run. Also, the user must choose the type of case to be run; either a DNL (Day/Night average sound level) case or an SEL (Sound Exposure Level) case. A DNL case is the standard case that comprises a large number of daily operations with a specific aircraft mixture for a given airport. An SEL case shows the noise impact of a single aircraft using a single arrival or departure flight track.

Choosing to Create or Use an Existing File

After selecting "Continue" on the NIM home page, the user is taken to the Scenario File Locator page (See Figure D-2). On this page, the user has four options; to use the default scenario, to download a previous scenario file, to build a new scenario file, or to upload a scenario file. Building a scenario case study is the more common and complex option and is discussed in the following section.

If downloading or uploading a previous scenario file is selected, then the user will be taken to a web page labeled "ASAC Noise Impact Scenario File Finder". At this point, the user is prompted to select a file for download from the ASAC server. Upon selecting a file and pressing "Continue", the analyst is given the two options. One option button is "View/Edit." Selection of this option will take the user to the "ASAC NIM Scenario File Editor"(described below) and allows the user to change details of the original scenario file. The other option is to press the "Continue" button and proceed directly to the "Run the Noise Impact Model" web page.

SCENARIO 1: BUILDING A STANDARD CASE

Step 1: Selecting An Airport

When selecting to "Build" a new scenario, the screen will change to the "ASAC NIM. DNL Contours. Scenario File Builder- Select Airport" screen, shown in Figure D-3. Scroll through the list of 17 available airports and select one for the current scenario. Press "Continue" and proceed to the "Select Study Year" screen.

Step 2: Selecting the Study Year

Figure D-4 illustrates the screen where the user is able to select the study year for the current scenario. The user selects a case year; either 1993, 2005, or 2015. This selection determines the census data and aircraft mixture that are used for the case study. When selection is complete press “Continue” and proceed to the “Edit Aircraft Operations Scaling Parameters” screen.

Step 3: Editing Aircraft Operations

The user has the option of changing the scaling of the aircraft mixture (see Figure D-5). Adjusting the scaling allows the user to see the noise impact of increased/reduced operations of a specific aircraft type. Users can adjust three types of aircraft with two different ranges. The choices available are widebody jets, narrowbody jets, and propeller aircraft. Each of these categories are broken down into short-haul or long-haul aircraft. As stated previously, long-haul aircraft are defined as aircraft with an average stage length of over 1000 miles. When selection is complete press “Continue” and proceed to the “Select Flight Track Optimization” screen.

Step 4: Selecting Flight Track Optimization

Users select the individual runways for which they want the flight tracks to be optimized (See Figure D-6). Once a runway is selected, tracks using that runway will be optimized. Optimized runways appear on the output report. Also, all Time and Distance savings associated with the optimized flight tracks are reported. If no optimizable flight tracks are available, then no selections are offered and the user is prompted to proceed to the next page. When selection is complete press “Continue” and proceed to the “Select Runway Utilization Type” screen.

Step 5: Select Runway Utilization Type

If the airport selected is one of the three airports (ORD, LAX, or SFO) that has an alternative runway use configuration, then the user will have the option to add this data to the scenario output file (see Figure D-7). If the user selects this option, then NIM will configure the airport case to activate a different runway utilization percentage. If the airport does not have optimizable runway use, then the option will not appear onscreen and the user will be prompted to prompted to proceed.

All results are printed on the output statement. All capacity and delay values have been pre-computed as follows:

Table 2. Alternate Runway Use Effects

Airport	Default Capacity (Ops/Peak Hr)	Default Delay (Min/Op)	Alternate Capacity (Ops/Peak Hr)	Alternate Delay (Min/Op)
LAX	89	12.5	89	12.4
ORD	100	10.4	104	10.3
SFO	48	12.0	48	10.7

When selection is complete press "Continue" and proceed to the "Edit Global Noise Reduction Parameters" screen.

Step 6: Edit Global Noise Reduction Parameters

Similar to the scaling in Step 3, global noise reductions can be affected on wide-body, narrowbody, or propeller aircraft (see Figure D-8). Each category has text box in which a decibel reduction of 0-40 decibels is entered. Before proceeding, apply the noise reductions by selecting "Use" on the right side of the "Global Parameters" box. The purpose of this procedure is to allow global changes to be applied to a an uploaded file. After entering all parameters and pressing the "Continue" button the user proceeds to the "Edit Aircraft Noise Reduction Parameters" page.

Step 7: Edit Aircraft Noise Reduction Parameters

Figure D-9, shows the aircraft mixture for a particular airport for a given year. All of the global noise reductions import from the previous screen. This page allows the user to make noise reduction adjustments on individual aircraft . Like the global parameters on the previous page, noise reduction can be set between 0 and 40 decibels. If the user does not wish to adjust the aircraft mix, then they press Continue and proceed to the "Select Number of Noise Level Contours" page.

Step 8: Select number of Noise Level Contours

Users have the option of selecting from 1 to 5 Noise Contour levels (see Figure D-10). The term contours refers to graphical indication of sound levels on the graphical (i.e. picture map) output file. When selection is complete press "Continue" and proceed to the "Edit Values for the Noise Contour Level" screen.

Step 9: Edit Values for the Noise Contour Level

Select the decibel values for the contour levels selected in Step 8 (see Figure D-11). The decibel values must be between 55-85 decibels and in descending order (i.e. Contour 1=75db, Contour 2=70db, etc.). When selection is complete press "Continue" and proceed to the "Select Whether or Not to Edit Flight Tracks" screen.

Step 10: Select Whether or Not to Edit Flight Tracks

If "Edit Flight Tracks" is chosen, the user proceeds to the "Edit Flight Tracks" screen. If it is not selected, then the user proceeds to Step 12.

Step 11: Edit Flight Tracks

All available arrival and departure flight tracks are listed here. The user selects which flight tracks to edit and enters the changes into the text box. When selection is complete press "Continue" and proceed to the "Select Whether or Not to Use New Aircraft" screen.

Step 12: Selecting Use or Non-Use of New Aircraft

This screen allows the user to add a new aircraft to the aircraft mix. This will be described further in the "Select New Aircraft" case description below. Selecting "No New Aircraft" allows the user to proceed to the "Edit Comments" screen.

Step 13: Edit Comments

The user can enter comments which will appear in the scenario output file. When selection is complete press "Continue" and proceed to the "Save Changes" screen.

Step 14: Save the Scenario File and Run the NIM

After setting all parameters, the user is given the option of naming and saving the scenario file. After saving the file, the user proceeds to the "Run the Noise Impact Model" web page. After pressing the "Run" button, the model is started and the user is notified by e-mail when the scenario run is complete.

Step 15: Download the Output Files:

The NIM DNL case outputs three files; a text file with all output data and two graphic file showing the noise contours around the airport. One graphical output file functions as a legend to the other graphic file, which shows the noise contour levels in color. To download the output files direct the browser to the following download site ftp://ftp.asac.lmi.org/pub/Models/Output. Output files may also be downloaded through the ASAC Model Wizard file manager.

Figure 4 shows a typical output table with results for a notional airport ("COM") in 2005 with optimized runway use configuration, optimized flight tracks on two of the runways, all operations levels kept at their defaults, and the noise levels for narrow-body aircraft reduced by 10 dB. The graphical output file displays a picture of the airport vicinity overlaid with the selected noise contour intervals—as shown for Orlando International Airport (MCO) in Figure 5. The graphical files are in .jpeg format and can be used within a wide variety of software products.

Figure 4. Sample NIM Output Table

Airport Efficiency Scenario Report For				**COM**
Execution date		01-Oct-97		
Year	Runways optmized?	Flight track optimization (by runway)		
2005	Yes	35L, 36R		
Noise reductions				
Narrow-body aircraft	10 dB			
Changes in airfield capacity and delay				
Standard		Optimized		
Capacity(ops/hr)	Delay (min/opn)	Capacity(ops/hr)	Delay (min/opn)	
36	33	37	24	
Time and distance savings per operation per track				
Track	Time (sec)		Distance (nm)	
6	41		5.5	
10	39		5.2	
Aggregate savings per aircraft type				
Aircraft	Time (min/year)	Distance (nm/year)	Operations/year	
735	14	111.5	21.6	
72F	2.4	18.9	3.7	
Noise impact statistics				
Noise Contour	Population (people)	Housing (units)	Census Area (sq. acres)	
60 DNL	9339	3384	13484	
65 DNL	1291	458	3662	
70 DNL	178	55	491	
75 DNL	16	5	21	

Figure 5. NIM Batch Program Graphic Output

SCENARIO 2: CREATING A SINGLE NOISE EVENT

Under this scenario, only one aircraft and one flight operation is used. A single event or SEL case is begun by selecting the "SEL Case" option on the NIM Home page (Figure D-1).

Step 1: Selecting an Airport

When selecting to "Build" a new scenario, the screen will change to the "ASAC NIM. SEL Contours. Scenario File Builder- Select Airport" screen. Scroll through the list of 17 available airports and select one for the current scenario. Press "Continue" and proceed to the "Select Study Year" screen.

Step 2: Selecting the Study Year

This page allows the user to select the study year for the current scenario. The user selects a case year; either 1993, 2005, or 2015. This selection determines the census data and aircraft mixture that is used for the case study. When selection is complete press "Continue" and proceed to the "Select Aircraft to Use" screen.

Step 3: Selecting the Aircraft to be used for the Single Event Study.

At this point, the user is able to select an aircraft for the current scenario. This selection determines the census data and aircraft mixture that are used for the case study. If the user wants to create a new aircraft, then proceed forward until reaching the “Add New Aircraft Screen.” When selection is complete press “Continue” and proceed to the “Edit Aircraft Noise Reduction Parameters” screen.

Step 4 Select Aircraft Noise Reduction Parameter

Like the global parameters in the DNL case, noise reduction can be set between 0 and 40 decibels. When selection is complete press “Continue” and proceed to the “Select Number of Noise Contours” screen.

Step 5 Select Number of Noise Contour Levels

Users have the option of selecting from 1 to 5 Noise Contour levels (see Figure D-10). The term contours refers to graphical indication of sound levels on the graphical (i.e. picture map) output file. When selection is complete press “Continue” and proceed to the “Edit Values for the Noise Contour Level” screen.

Step 6: Edit Values for the Noise Contour Level

Select the decibel values for the contour levels selected in Step 5. The decibel values must be between 55-85 decibels and in descending order (i.e. Contour 1=75db, Contour 2=70db, etc.). When selection is complete press “Continue” and proceed to the “Select Flight Track” screen.

Step 7 Select a Flight Track

Select one of the arrival or departure tracks listed for the airport selected. When selection is complete press “Continue” and proceed to the “Edit Flight Track” screen.

Step 8 Edit a Flight Track

This screen allows the user to adjust the existing flight track chosen in Step 7. When selection is complete press “Continue” and proceed to the “Chose a New Aircraft or Not” screen.

Step 9 Chose Whether or Not to Use a New Aircraft

At this point, the user is presented with the option of adding a new aircraft, which will be described in detail in Scenario 3.

Scenario 3: Adding a New Aircraft

To add a new aircraft type, the NIM must collect all required INM noise and performance parameters. Please see the INM 4.11 user’s guide for detailed information on these parameters. The “ASAC NIM Add a New Aircraft” incorporates the parameter tables listed below. Overall, the two basic stages for creating a new aircraft type are described below.

Stage 1: Assign Parameter Set Names:

- New aircraft name.
- Body type (Wide, Narrow, or Propeller)
- Number of Annual Operations
- Category (JCOM, JGA, JMIL, PCOM, PGA, PMIL)
- Noise curve name, number of thrust values, and number of detection points.
- Approach parameters name.
- Approach profile name and number of segments.
- Takeoff profile name and number of segments.

Stage 2: Assign Parameter Values:

Noise Curve Data

Enter noise curve data into the form. The number of values for EPNL and SEL data = (number of thrust values) * (number of detection points). This table describes the measured decibel level of a particular aircraft cross-referenced by a thrust level and the distance from the aircraft.

	Thrust 1	Thrust 2	Thrust 3
Distance 1	113.7 (db)	115.7	121.2
Distance 2	108.2	110.2	115.8
Distance 3	104.3	106.3	111.8
Distance 4	100	102	107.5

Aircraft Characteristics

Enter the aircraft weight and number of engines (part of approach parameter data) into the form.

Weight	Number of Engines
10,000	2

Enter the approach profile performance characteristics into the form.

Segment	1	2	3	4	5	6	7
Distance	20	10	5	3	1	0	0
Altitudes	6000	3236	1644	1007	370	0	0
Speeds	160	160	160	160	160	32	0
Thrusts	1	1	1	1	1	1	1

Enter the takeoff profile performance characteristics into the form.

Segment	1	2	3	4	5	6	7	8
Distance	0	1376	4126	6876	6877	9626	10000	15000
Altitudes	0	0	500	1000	1000	1500	1500	1500
Speeds	32	160	160	160	160	160	160	160
Thrusts	2	2	2	1	1	1	1	

The following sections cover a specific case of creating a new aircraft using the current version of the Noise Impact Model. When creating either a DNL or SEL case the user is prompted about whether or not to create a new aircraft. If a new aircraft is to be created, then the user is lead through a series of screen prompts. Creation of a new aircraft is a complex process and requires an in depth knowledge of INM 4.11 inputs.

Step1: Edit Base Parameters for New Aircraft Screen

There are five pieces of key information that need to provided;

- New Aircraft Name
- Aircraft Body Type- Widebody, Narrowbody, or Propellor.
- Number of Operations- For a DNL case only.
- Aircraft Stage Length
- Desired Aircraft Noise Reduction- Must be between 0-40 decibels.

Step 2: Choose Number of Thrusts and Distances for Noise Curve table

This selection determines the number of Thrust Columns versus the number of Distance Rows in the Thrust versus Distance table described in the "Assign Parameter Values" section above. After completing this selection and pressing the "Continue" button, the next screen is "Edit Values for Thrusts and Distances for New Aircraft"

Step 3: Editing Values for Thrusts and Distances

This screen allows column and row headers to be assigned to the noise curve table. The Thrust (Column) headers should be in increments of 1 (i.e. 1,2,3,…). These numbers will be used as a reference which relates a given decibel level in the table (in terms of distance) to the actual altitudes and distances being used for the case study. The Distance (Row) headers establish the distance at which a particular decibel level is heard in relation to a particular thrust setting.

Step 4: Creating Decibel Levels For EPNL and SEL Cases

The thrust versus distance tables have now been created for both EPNL and SEL cases. The next step now is to populate those tables with decibel data. The relation can now be seen between a Thrust level and a particular distance. Sample data are provided in the "Assign Parameters" section of Scenario 3. The Thrust versus Distance data for existing aircraft is found in Appendix G. Appendix G is a good starting point for anyone creating a new aircraft without specific knowledge of aircraft noise characteristics.

Step 5: Edit New Aircraft Weight and Engines

This screen allows adjustment to the weight of an aircraft and the number of engines.

Step 6: Edit Number of Segments for Approach and Take Off.

This screen sets the number of columns in the approach and take off parameters tables. Enough columns should be chosen to accommodate all changes in aircraft distance, altitude, speed, and thrust.

Step 7: Edit Approach and Take Off Parameters

Enter the distance, altitude, speed, and thrust values for each segment of the flight. The thrust values should relate back to the thrust values in Step 3.

Scenario 4: Adjusting a Flight Track(s)

Under this scenario, a user wishes to adjust the flight track(s) within a given scenario file. The user is given the choice to go to the "ASAC NIM Flight Track Adjustment" page after completing the "ASAC Noise Impact Model Scenario File Builder - Edit Values for the Noise Contour Levels". On this page, the user has the capability to edit all flight tracks for a given airport.

To select a track (s) to be modified, the user must check the box in the "Modified" column, which is located to the left of the flight track name and description. The next step is to modify the text command for the selected flight track located under the column "Command." The following key inputs must be used to define a flight track:

1. Straight- Indicates linear flight.

2. Right/Left- Indicates a turn to Port or Starboard.

3. D- Must be used to indicate a turn.

4. Degree of Turn- Direction for new heading relative to the current flight path.

5. Radius of the Turn- Describes the length of the radius of the turn.

The correct syntax for defining a flight track is as follows:

"Straight [# miles] [Left/Right] [# Deg.] D [Radius (1.74 miles)] Straight [50 miles]"

So, the correct syntax for a flight proceeding straight for 5.28 miles then turning 90 degrees and proceeding straight for 50 is as follows:

"Straight 5.28 Left 90 D 1.74 Straight 50"

Further examples can be found by looking directly at the "ASAC NIM Flight Track Adjustment" page for a particular airport.

Databases

The NIM integrates data drawn from a variety of sources into a comprehensive library providing the following information:

The INM database, INM input files, and/or airport sources provide the following data:

- Seventeen airports, their runways, height above sea level, and average temperature (these data are listed in Appendix C)
- Runway utilization for 1993 operations at each airport, by aircraft category
- The flight tracks used for arrivals and departures on each airport runway
- Flight track utilization statistics for each aircraft type
- The typical descent profiles for each aircraft type and several climb profiles, depending on how heavily loaded the aircraft is with fuel (more fuel for longer flights)

- Noise data for each operational profile for each aircraft type.

The ASAC relational database provides data about the specific types of aircraft operating at each airport, the number of departures executed during 1993, the operations levels projected for 2005 and 2015, and the average stage length each aircraft flies at that facility.

The following data were generated through analysis performed for this task:

- Capacity and delay values for the existing preferential runway usage patterns (based upon combined input from LMI-computed capacity delay data and airport/airline evaluations)

- Alternate runway utilization by aircraft category for optimized scenarios, the associated capacity and delay values for (LAX, ORD, and SFO).

- Alternate flight tracks designed to provide greater operating efficiency compared with existing noise-abatement flight procedures and the time and distance saved for ATL, BOS, CVG, EWR, JFK, LAX, LGA, MCO, MSP, SEA, and SFO

- A table translating the types of aircraft noted in the *Official Airline Guide* (OAG) into the equivalent types recognized by the INM.

The U.S. Census and commercially available databases provide these data:

- Population and housing densities surrounding each airport, subdivided geographically into census blocks

- Information defining the airport boundary and nearby bodies of water

- Airport property graphics.

Computational Modules

The two key computational modules in NIM are the FAA's INM and the airport noise impact calculation module using the geographic information system MapInfo Pro-Server.

INM Version 4.11

The industry standard for analyzing noise impacts from aircraft operations around airports is the FAA's INM. This model was originally developed in the early 1970s and has been upgraded several times since then. According to a recent FAA statement:

> The model is used by over 700 organizations in 35 countries to study changes in noise impact from new or extended runways or runway configurations, new traffic demand and fleet mix, revised routings and airspace structures, alternative flight profiles and modifications to air traffic control procedures.

Source code for the core modules of INM Version 4.11 (in Fortran) has been incorporated into NIM. To date, attempts to insert the comparable INM version 5.0 code into NIM have failed due to the unavailability of separable software modules.

GEOGRAPHIC INFORMATION SYSTEM FOR ASSESSING NOISE IMPACT

This methodology starts with the INM noise contours and census data, but it uses a population density distributed uniformly throughout the census block rather than assuming all people reside at the centroid of the census block. The algorithms also examine the surrounding land uses to discount the airport property and nearby bodies of water. The resulting assessment of the number of people and homes impacted is much more accurate than if the contour areas were applied directly to the population density defined for the census blocks.

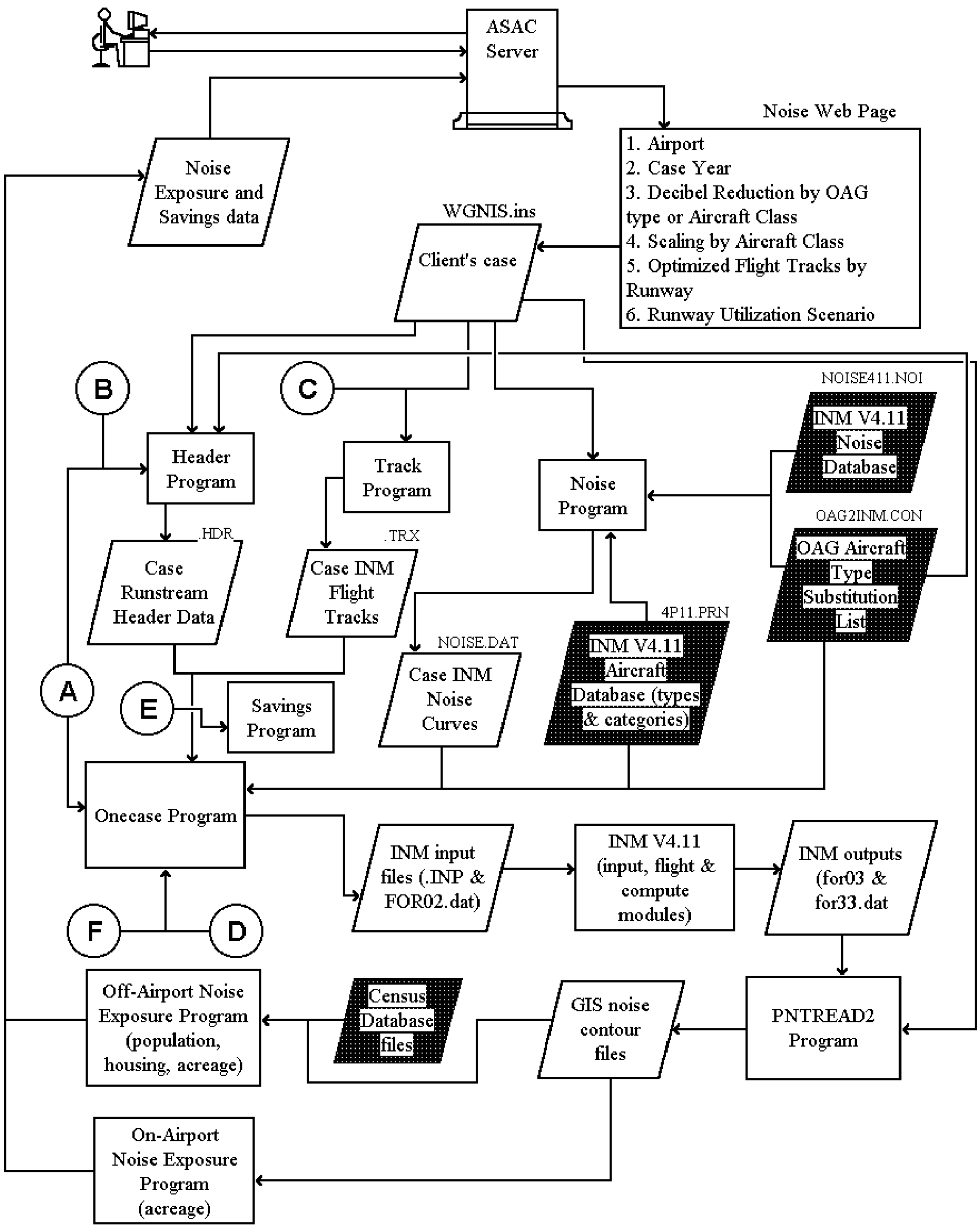
NIM uses the network mapping software, MapInfo Pro-Server, to integrate the noise level, land use, and census data into a comprehensive noise impact map that can be analyzed for the areas, population, and houses located within each of the contour bands for a given user scenario.

Connecting the Components

The connection and communication among the various components is accomplished through a set of customized routines that we developed for NIM. The functions of these routines are quite varied, from data preprocessing and user-selection translation, to geographic mapping conversions. Some of these functions were performed during the development of FTNIM and NIM and the results incorporated into databases. Other functions are activated each time NIM operates.

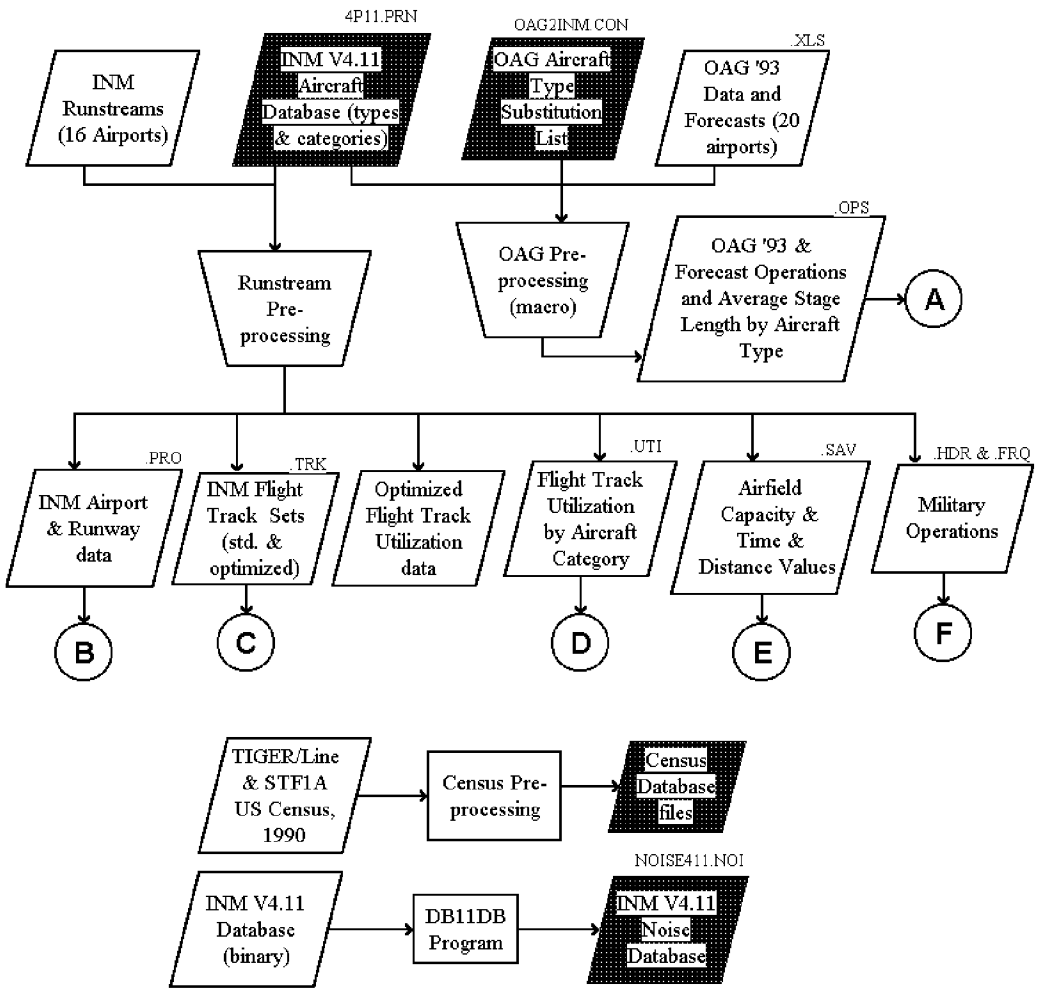
Figure 6 shows the data flow for NIM. Since the model is fully integrated into ASAC, users access the model through the ASAC server and make a series of choices, setting up the Client Case shown in the center top portion of the figure. At this point in the process, the Client Case exists as a set of data selections. At each stage, routines are required to evaluate the user's scenario and collect the necessary data from the databases. Then, the required operations are performed on the data to prepare them for use by the next program module. Several intermediate data files are created and used. These actions are described more fully in the Sample Calculation section of this report. All data groups and data tables appear in Figure 6 as parallelograms, while computational program elements are shown in boxes.

Figure 6. Data Flow for the NIM



In Figure 6, the circled letters A through F indicate points in the analysis where data are provided by subroutines not shown in the figure. These actions, shown in Figure 7, preprocess the data for integration into the other program elements.

Figure 7. Data Preparation For the NIM



SAMPLE CASE

This section describes a sample calculation and the data on which the calculations are based. There are three subsections: the first describes the databases used to perform the calculations and the steps used to preprocess the data. The second contains the calculation steps. The third subsection discusses the accuracy of the model.

Database Preparation and Data Preprocessing

Four databases are used in the entire process. Each one is described below. Data preprocessing consists primarily of the analysis of INM runstreams (input files) and OAG operations data.

INM AIRCRAFT TYPES AND CATEGORIES DATABASE (4P11.PRN)

The pertinent data in this file are the INM aircraft types from the V 4.11 database and their associated aircraft category (sample below). The two aircraft categories of "narrow-body" and "wide-body" have been established by the aviation industry.

Sample INM Version 4.11 database file section:

												0-500	500-1000	1000-1500	1500-2000	2500-3500
INM_ACID	INM_NO	DESCRIPTION	COS	CATNAME	NOI#	NOINAME	NOISTAGE	Body	E/B	LDP_NAME	LDP_ID	TOP_S1	TOP_S2	TOP_S3	TOP_S4	TOP_S5
747100	1	B747-100/JT9DBD	COS	JCOM	6	JT9DBD	1	W	4EWB	STD3D	1	1	2	3	4	5
747200	2	B747-200/JT9D-7		JCOM	7	JT9DFL	2	W	4EWB	STD3D	2	7	8	9	10	11
74710Q	3	B747-100QN/JT9D-7QN		JCOM	7	JT9DFL	2	W	4EWB	STD3D	3	14	15	16	17	18
747SP	4	B747SP/JT9D-7		JCOM	7	JT9DFL	2	W	4EWB	STD3D	4	20	21	22	23	24
74720B	5	B747-200/JT9D-7Q		JCOM	50	JT9D7Q	3	W	4EWB	STD3D	5	27	28	29	30	31
DC820	6	DC-8-20/JT4A	COS	JCOM	1	JT4A	1	N	4ENB	STD3D	6	34	35	36	37	38
707	7	B707-120/JT3C	COS	JCOM	1	JT4A	1	N	4ENB	STD3D	7	40	41	42	43	44
720	8	B720/JT3C	COS	JCOM	1	JT4A	1	N	4ENB	STD3D	8	46	47	48	49	50
707320	9	B707-320B/JT3D-7	COS	JCOM	2	JT3D	1	N	4ENB	STD3D	9	51	52	53	54	55
707120	10	B707-120B/JT3D-3	COS	JCOM	2	JT3D	1	N	4ENB	STD3D	10	58	59	60	61	62
720B	11	B720B/JT3D-3	COS	JCOM	2	JT3D	1	N	4ENB	STD3D	11	64	65	66	67	68
DC850	12	DC-8-50/JT3D-3B	COS	JCOM	2	JT3D	1	N	4ENB	STD3D	12	69	70	71	72	73
DC860	13	DC-8-60/JT3D-7	COS	JCOM	2	JT3D	1	N	4ENB	STD3D	13	75	76	77	78	79
DC870	14	DC-8-70/CFM56-2C-5		JCOM	4	CFM562	3	N	4ENB	STD3D	14	82	83	84	85	86
BAE146	15	BAE 146-200/ALF502R-5		JCOM	5	AL502R	3	N	4ENB	STD3D	15	89	90	91		
707QN	16	B707-320B/JT3D-7QN		JCOM	3	JT3DQ	2	N	4ENB	STD3D	16	92	93	94	95	96
DC8QN	17	DC-8-60/JT8D-7QN		JCOM	3	JT3DQ	2	N	4ENB	STD3D	17	99	100	101	102	103
CONCRD	18	CONCORDE/OLY593		JCOM	8	OLY593	1	N	4ENB	STD3D	18	106	107	108	109	110
DC1010	19	DC10-10/CF6-6D		JCOM	11	CF66D	3	W	3EWB	STD3D	19	112	113	114	115	116

OAG AIRCRAFT TYPE SUBSTITUTION LIST (OAG2INM.CON)

This file lists the OAG aircraft types and the comparable INM aircraft type on the basis of noise levels each aircraft generates (Table 3). "OAG_A_Profile" shown in column 3 indicates the departure climb profile used for each aircraft's operations. "STD3D" is the standard default climb procedure specified for each aircraft type. It defines engine thrust, climb gradient, and air speed as functions of the distance from the start of takeoff roll.

Table 3. Sample OAG to INM Substitution List

OAG_type	INM_type	OAG_A_profile	Description
310	A310	STD3D	Airbus A310 (all series)
320	A320	STD3D	Airbus A320
727	727Q7	STD3D	Boeing 727 passenger jet (all series)
72F	727EM2	STD3D	Boeing 727 freighter (200)
733	737300	STD3D	Boeing 737-300
734	737400	STD3D	Boeing 737-400
743	74720B	STD3D	Boeing 747-300 SUD
744	747400	STD3D	Boeing 747-400
757	757RR	STD3D	Boeing 757 (all series)
75F	757RR	STD3D	Boeing 757-200pf freighter
763	767300	STD3D	Boeing 767-300/300ER
767	767CF6	STD3D	Boeing 767 (all series)

CENSUS DATABASE FILES (.TAB, .MAP, .ID, .DAT, .IND)

The NIM census database files contain three different sets of data: cartographic data, population data, and households data. To achieve this, three different databases have been combined and processed:

- TIGER/Line census files (1990, 1992, and 1995 releases), which provided the cartographic data
- Census summary tape file 1A (STF1A), which provided the framework for the population and households data
- Woods & Poole Economics, Inc. 1994 regional forecast and database, from which the actual population and households information were extracted.

The TIGER/Line files database is a product of the U.S. Bureau of Census and consists of selected geographic and cartographic information extracted from the U.S. Census Bureau's TIGER database. For this project, only the cartographic information was needed. These data represent the structure definition of the polygonal shapes that when combined make up the census areas of the different counties of interest. The criterion for selecting the counties was that they had to be located, even if only partially, within a 20-mile radius from the chosen airport. The degree of resolution of the resulting maps was chosen to be at the "block group" level since that is the maximum resolution common to all the types of census data that were needed. A block group is a combination of census blocks that is a subdivision of a census tract or Block Numbering Area (BNA).

Once extracted, the selected TIGER/Line database data were refined by removing bodies of water and airport property from the analysis. This step was necessary in order to obtain a more accurate representation of the actual population and households distribution and density after joining the population and household data with the cartographic data. If such refinement had not been done, the resulting map would have had population and households equally distributed between land and water, or airport property, where these happened to be included in the same block group. In the context of census data, households are defined as occupied housing units.

The 1990 Census STF1A is another product of the U.S. Census Bureau containing data about all persons and housing units in the United Sates. The data extracted from this database were used, however, only to calculate the coefficients necessary to derive the population and households figures for each county block group from the county totals. This procedure was necessary because the U.S. Census Bureau provides forecasts for only a few years into the future and the database that contained the required projections had only a county-level resolution. The population coefficients were calculated as follows:

$$Coeff_{POP} = \frac{BG_{POP}}{Cty_{TOTPOP}}$$

where:

$Coeff_{POP}$	=	Population coefficient
BG_{POP}	=	Block group population figure
Cty_{TOTPOP}	=	County total population figure

The households coefficients also were calculated in the same manner:

$$Coeff_{HOUS} = \frac{BG_{HOUS}}{Cty_{TOTHOUS}}$$

where:

$Coeff_{HOUS}$	=	Households coefficient
BG_{HOUS}	=	Block group households figure
$Cty_{TOTHOUS}$	=	County total households figure

The coefficients were then multiplied by the county total population and households data for the years 1993, 2005, and 2015 extracted from the Woods & Poole database giving resultant projected block group figures. This procedure assumes that while the overall population may change by some percentage, the *distribution* of population and households within each county will remain unchanged.

As previously stated, the last database used, the Woods & Poole Economics, Inc. 1994 Regional Forecast and Database, provided the projected data for the years 1993, 2005, and 2015. Woods & Poole used the corrected census data from 1969 to 1992 as a starting point and then developed their forecast using a four-stage process.

First, the forecast for the entire United States was developed. This first projection was needed to provide a "control set" of data. Then, the United States was divided into 183 economic areas (EA) and employment and earnings projections were calculated for each of them. These forecasts then were used in the third stage as the principal explanatory variables used to estimate the population and households figures for each EA. The last stage repeated the process of the previous two stages to create forecasts at the county level. In this stage, the EA figures were used as control values. The main strength of this forecast technique lies in the comprehensiveness of the county database and the integrated nature of the model. In fact, each change in one of the counties effects not only that county, but its neighboring counties as well.

We had to extrapolate the analysis for several geographical areas, including Fairfax (VA), Fairfax City (VA), Falls Church (VA). Prince William County (VA), Manassas City (VA), and Manassas Park City (VA). These areas were grouped together in the Woods & Poole database, but not in the Tiger/Line or in the STF1A databases. As a result, to maintain a consistent data set, coefficients had to be calculated in order to create data sets for each single area. The calculation of the coefficients was performed with the same technique used for the block group data sets. The equations used were the following:

$$AreaCoeff_{POP} = \frac{Area_{POP}}{Set_{TOTPOP}}$$

where:

$AreaCoeff_{POP}$	=	Area population coefficient
$Area_{POP}$	=	Area population figure
Set_{TOTPOP}	=	Set of areas total population figure

and

$$AreaCoeff_{HOUS} = \frac{Area_{HOUS}}{Set_{TOTHOUS}}$$

where:

$AreaCoeff_{HOUS}$	=	Area households coefficient
$Area_{HOUS}$	=	Area households figure
$Set_{TOTHOUS}$	=	Set of area's total households figure

The data necessary to perform these calculation were extracted from the Census 1990 STF1A database.

INM NOISE DATABASE (NOISE411.DAT)

This file contains the sound exposure level (SEL) and effective perceived noise level (EPNL) values for slant range distances for all available V4.11 aircraft types as extracted from the FAA's INM database. The slant range distance is the straight line distance between the aircraft and the receiver grid point on the ground.

PREPROCESSING OAG OPERATIONS DATA

Operational data for each study airport were provided by LMI and contained the number of operations by OAG aircraft type for the years 1993, 2005, and 2015. For 1993 departures, the data also contain the average stage length in statute miles.[1]

The data are then processed with an Excel macro that, with the help of the INM Aircraft Types and Categories database and the OAG Aircraft Type Substitution List, lists the operations for 1993 and forecast years and, for departures, the average stage length by OAG aircraft type, sorted by the aircraft classes. An aircraft class is defined as the combination of a quantitative descriptor of the stage length (long- or short-haul) and the aircraft category (i.e., narrow-body, wide-body, other). The "long" category is one having a minimum average stage length of 1,000 statute miles (equivalent to INM stage length 3). The Excel macro writes the .OPS file.

Sample .OPS file:

```
"NARROW","LONG",1
"D93",1200,3000,0,0
"WIDE","LONG",1
"744",1200,3500,4240,6020
```

[1] Stage length is defined as the great-circle distance from the airport of origination to the airport of destination.

The sample shown above is for two aircraft, a McDonnell Douglas DC9-30 and a Boeing 747-400. The following information for the DC9 appears in the first two lines; the classification as a narrow-body, long-haul aircraft; "1" for departures; type as a D93; average stage length of 1,200 statute miles; 3,000 annual operations in 1993; 0 operations in 2005; and 0 operations in 2015. Similar data are given in the next two lines for the 747 indicating the same average stage length but increasing numbers of operations.

PREPROCESSING INM RUNSTREAMS

INM runstreams of typical operations for each study airport were obtained and analyzed through semi-automated and manual processes. The products of the preprocessing are up to six files for each airport. These files are described in the following subsections.

INM Airport and Runway Data

The first three sections of each INM runstream containing the airport name/identifier, information on climate, and runway coordinates were extracted and written to the .PRO file.

Sample .PRO file:

```
"AIRPORT","COM"
"ALTITUDE",96,"TEMPERATURE",23.0,"C"
"RUNWAYS",1
"RW","36R","18L",50000,23000,50000,35004,359
```

For notional airport "COM," the airfield altitude is given as 96 feet above mean sea level and the year-round average temperature is 23.0 degrees centigrade. COM has just one runway, designated 36R/18L, with one end point at coordinates (50000, 23000) and the other end point at coordinates (50000, 35004). The actual runway orientation is 359 degrees.

Runway Use Configurations

An airport has one set of runways that can be used in several different configurations depending on weather conditions, wind, air-space management issues, aircraft mix, noise restrictions, etc. Each configuration defines runway use percentages, which potentially affect the airfield capacity.

To look at preferential runway use based on noise and its effect on airport capacity, it is first useful to consider the factors that determine the capacity of an airfield. Aggregate airport capacity is a sophisticated concept, affected by multiple variables. These include the number of gates at the terminal, the overall capacity of the terminal, the number and length of the runways, the capacity of the taxiways, and the parking capacity. Each of these variables is usually affected by several additional factors. For example, the way the runways are combined so that some are used for arrival and others for departure under given weather conditions, has a significant impact on capacity. Further, the navigational aids installed, especially for arrivals, can determine capacity when the weather is poor and instrument flight rules are applied.

Noise compatibility problems, generally caused by residential areas being encroached by airport noise, will cause a community noise problem. If the airport responds to citizen complaints by restricting the use of certain runways, capacity can be affected. Generally, these runway restrictions are formalized in a "preferential runway use plan" that identifies which runways are preferred for arrivals or departures so that noise impacts are minimized. These restrictions may be aimed at nighttime operations only, or may be enforced throughout the day. Generally, however, noise abatement considerations are given less priority than safety and peak hourly capacity issues. So, even when preferential runway use schemes have been defined, they are generally only implemented during off-peak hours.

For the three NIM airports for which an alternate runway use scheme is available, we used ASAC data for the base case capacity and delay values. We also used historical data obtained from airports, as well as limited assumptions based on this historical data and dialogue with airports relating to optimized runway use configurations. Our data included the capacity and delay values associated with typical runway use configurations. Then, we developed alternative configurations that could be expected to improve the efficiency of aircraft movements. In all cases, we coordinated closely with the airport staff at LAX, ORD, and SFO to be sure our assumptions about alternate configurations were realistic.

First, we used the ASAC configuration-specific capacity data as a starting point. Then, we contacted the airports to determine percentage of time that operations at an airport use a particular runway configuration on an annual basis. This collected information is based on two operational scenarios: (1) the Current Scenario runway use configurations used and (2) the Alternate Scenario runway use configurations that would be used without noise as a consideration. By comparing each runway use configuration to the hourly capacities figures, we derived, based on weighted averages, an Average Annual Hourly Capacity (AAHC) for each scenario. AAHC is a single number descriptor of overall field capacity.

The single number AAHC was necessary because the INM recognizes runway usage in a very different form than normally described by airport operators. INM accepts the assignment of aircraft operations to flight tracks and the attachment of tracks to runways, for an annual average day. This means that information regarding how runways are used in combination (the form of data normally used to analyze capacity) must be translated into utilization percentages for individual runways. In addition, runway utilization framed in terms of different weather conditions must be combined in a weighted average to describe operations for an annual-average day. Our engineers have analyzed airport inputs to reformat them for use in the INM. The capacity values, discussed in more detail below, are determined by the airfield configuration and do not change with the number of operations. So, the capacity remains the same for all three case years, 1993, 2005, and 2015.

The capacity information accounted for four weather conditions, as well as wet and dry conditions. Since we extracted percentages concerning time in a given weather condition, it was possible to apply this information accurately to any projected runway use configuration developed. The AAHC, derived for the airport's current operational scenario and based on real numbers, provides a valid reference. The percentages relating to capacity changes are based on the estimated time a more efficient configuration would be available. Basing available runway configurations on the factors discussed above, as well as historical wind conditions, we arrived at a runway configuration that would most likely be used without noise as an issue. By analyzing this configuration, a value suggestive of how the AAHC may change, was derived based on the implementation of the new configuration.

Once we developed a rationale for expressing AAHC, each of the three airports was examined to determine the change in capacity that might result from a change in runway use patterns. Many members of the aviation community have expressed the belief that releasing noise concerns and changing runway usage would significantly improve the capacity of the target airfields. Our analysis, however, has not shown the degree of improvement that had been hoped. The primary reason for this is that when airports are experiencing peak demand, they generally relax the noise abatement preferential runway use rules. Consequently, relaxing the rules for the rest of the day will provide improvements in efficiency only on the off-peak operations. In effect, the capacity of the airport is not as heavily impacted by noise abatement as many in the industry have expected. For this reason, the change in capacity reported by NIM for LAX, ORD, and SFO (shown in a previous section) reveal improvements of zero (LAX), one percent (SFO), and 3.7 percent (ORD).

The cost of noise abatement is determined by the delay time incurred at the airport as a result of preferential runway use schemes. These schemes may require longer taxi times to get to the preferred runway, and usually cause delay in waiting for the other aircraft that also must use the designated runway. Once delay values are known, the cost is determined by multiplying the time lost by the cost of operating an airliner, including fuel, crew salary, and increased aircraft maintenance requirements. This will generate a dollar amount suggestive of the cost each year to aircraft operators of using preferential runway use programs based on noise.

The basic airfield delay values were subject to the same limitations noted for the capacity values. That is, the delay related to noise abatement was difficult to discern directly, because noise abatement restrictions are minimized during peak operating hours. Instead, we focused on determining the change in time for ground movements. Ground movements are factored into our analysis in a general way, but without the level of detail that is necessary to "tease out" the specific cause (noise abatement) and effect (special delay) relationship that we were looking for. Then, our ground delay factor could be used to modify the existing airfield delay values that the our modeling documented.

The methodology for determining ground delay determined likely trends. Therefore, it is not specific enough for use in strategic planning at any of the airports considered. Because significant delays occur primarily during the taxi-out phase of an aircraft journey, only departure operations were addressed in the analysis.

Based on discussion with airport personnel at ORD, LAX, and SFO, we obtained information delineating runway usage. These were broken down into the Current Scenario and Alternate Scenario categories. In addition, we collected data including runway use by day and hour for December 1997 for each airport. These data were cross-referenced with average median delay data, collected from the FAA. The delay data were broken down in the same format for the month of December. Using weighted averages, the average delay was calculated for both the Current and the Alternate Scenarios. The difference in the delay numbers indicated a savings, in minutes, that would likely occur if aircraft were to fly without regard for noise policy. Except for LAX, this savings is one that would most likely effect all aircraft using the most common runway usage configurations at the airport. The delays at LAX, based on discussions with airside airport operations personnel, would be realized only by cargo operators located on the south side of the airport complex.

INM Flight Track Sets

For each modeled runway of each study airport, the flight tracks from the INM runstream were extracted. These are the default flight tracks. Each default track was studied for potential noise-abatement modifications. If the flight track could be improved to fly a more direct route, the revised track then was considered an "efficient" flight track.

The guidelines used to determine the potential for modifying a default flight track include the following criteria:

- The INM flight track could be clearly associated with other published information an airport provided about its defined noise-abatement procedures. Most airports develop pilot instructions for flying noise-abatement routes. These texts can be compared with the flight track shown in the INM runstream.
- A realistic alternate route could be identified that would be safe, practical in terms of equipment performance, and would not infringe on other active airspace.
- The alternate track would provide measurable distance savings when compared with the existing noise-abatement track.

The standard and associated efficient flight tracks were written to the .TRK file for each study airport, sorted by runway. In some cases, these are tracks that already existed in the INM file but were restricted to commuter operations. In other cases, we defined new tracks based on airport staff input and analysis of other operational and procedural considerations.

The sample file describes some of the flight tracks at COM. The first set of tracks shown is for operations departing from runway 36R. There are five existing abatement tracks called by numbers 2 through 6. The first track, number "2," starts with a straight segment of 5.28 miles. Then, the track turns left 90 degrees through a turn radius of 1.74 miles. The final segment is straight for 50 miles, at which time the aircraft has left the airport's vicinity. Note that the nonabatement track 2 is identical to the abatement track. For the file sample shown here, only track 6 differs between the abatement and nonabatement cases. The abatement procedure includes a turn to the right of 270 degrees, while the nonabatement case turns 90 degrees.

Sample .TRK file:

```
"AIRPORT","COM"
"DEPARTURES",1
"36R",1
"ABATEMENT"
"2","STRAIGHT 5.28 LEFT 90 D 1.74 STRAIGHT 50"
"3","STRAIGHT 5.28 LEFT 20 D 1.74 STRAIGHT 50"
"4","STRAIGHT 1.97 RIGHT 20 D 1.74 STRAIGHT 50"
"5","STRAIGHT 1.97 RIGHT 60 D 1.74 STRAIGHT 50"
"6","STRAIGHT 1.97 RIGHT 270 D 1.74 STRAIGHT 50"
"NON-ABATEMENT"
"2","STRAIGHT 5.28 LEFT 90 D 1.74 STRAIGHT 50"
"3","STRAIGHT 5.28 LEFT 20 D 1.74 STRAIGHT 50"
"4","STRAIGHT 1.97 RIGHT 20 D 1.74 STRAIGHT 50"
"5","STRAIGHT 1.97 RIGHT 60 D 1.74 STRAIGHT 50"
"6","STRAIGHT 1.97 LEFT 90 D 1.74 STRAIGHT 50"
"ARRIVALS",1
"36R",1
"ABATEMENT"
"B","STRAIGHT 50"
"NON-ABATEMENT"
"B","STRAIGHT 50"
```

Flight Track Utilization by Aircraft Class

Using a FORTRAN program, the operations in each INM runstream are grouped by class and summed within each class by flight track. The program then determines the percentage of the associated class' operations occurring on each flight track in daytime, evening (if applicable), or nighttime periods. For example, the program calculates, among all long-haul wide-bodied class of aircraft operations at airport COM, flight track 16 is used 82.1 percent during the daytime and 7.01 percent during the nighttime The program writes the percentages (in decimal format) to one .UTI file representing operations using the standard runway use configuration. A second .UTI file is created in which the operation numbers have been scaled to reflect the optimized runway use scenario.

Sample .UTI file:

```
CLASS,TRACK,DAY,EVE,NITE
"LW","16"," .821"," .00000"," .0701"
```

This sample file shows data for long-haul, wide-bodied aircraft (LW) on track number 16. The values shown indicate that 82.1 percent of the daytime LW flights use this track, no operations occur on it during the evening hours of 7 P.M. to 10 P.M., and 7.01 percent of the nighttime LW operations use it from 10 P.M. to 7 A.M.

Airfield Capacity and Delay Values

The change in airfield capacity is defined by the difference in the number of peak arrivals and departures per hour—for the standard and optimized runway use configurations. The delay is specified in minutes per operation for both configurations. For each study airport, the airfield capacity and delay values for the standard and alternate configurations are stored in the RUNIM.SAV file.

Sample RUNIM .SAV file:

The first pair of numbers is capacity measured in operations per hour and average delay per operation, respectively, for the standard configuration while the second pair of numbers is for the optimized runway use pattern.

```
“COM”
"36","33","37",”24”
```

The first pair of numbers is capacity measured in operations per hour and average delay per operation, respectively, for the standard configuration while the second pair of numbers is for the optimized runway use pattern.

Time and Distance Values

The time spent and the distance traveled by aircraft that use the standard and efficient flight tracks are computed and written to a file. The time spent is computed by dividing the distance traveled in nautical miles by an average cruising speed. This cruising speed is specific to each airport and is computed as the weighted average of aircraft cruising speeds for the aircraft operating at the airport, with the weighting based on the number of daily departures. These data are kept in the .SAV file, which is specific for each airport.

Sample .SAV file:

```
"16","4.8","53"
```

As shown in this file, flight track 16 offers a savings of 4.8 nautical miles and 53 seconds for every operation.

Military Operations

If military aircraft operations exist in the INM runstreams, their runstream header and frequency (operations) data are extracted and written to the .HDR and .FRQ files, respectively. This step is performed prior to determining the Flight Track Utilization by Aircraft Category. The NIM will hold military operations constant for all user scenarios.

Calculation Steps

With the databases and data preprocessing having been covered, it is now appropriate to describe the basic steps necessary to run a user-supplied operational scenario to compute noise-exposure, changes in airfield capacity, and time/distance savings data.

SAMPLE SCENARIO

The following list defines a notional operational scenario:

- Airport: COM
- Case Year: 2005
- Decibel Reduction by OAG type or Aircraft Category:

Table 4. Global Aircraft Parameters

Aircraft type	Reduction (dB)
Long-haul, wide-body (LW)	0
Long-haul, narrow-body (LN)	3
Short-haul, wide-body (SW)	0
Short-haul, narrow-body (SN)	0

Scaling by Aircraft Category:

Table 5. Aircraft Scaling

Class	Scaling
LW	125%
LN	150%
SW	0
SN	0

- Optimized Runway Use Configuration
- Efficient Flight Tracks by Runway: Runways 35L and 36R

COMPUTING NOISE EXPOSURE DATA

The main goal of this task is to determine the off-airport land acreage, number of dwellings, and population within the noise-exposure contours. This involves the creation of a runstream for the INM based on the user-supplied inputs. The INM then creates the noise-exposure contours that the GIS will use to determine noise impacts. To accomplish the main goal, seven programs are executed: Header, Track, Noise, Onecase, INM, PNTREAD2, and Popcount. Each of these programs is described in the following seven subsections.

Header Program

The Header program determines the INM aircraft types associated with the user's case. It accomplishes this by reviewing the portion of the COM.OPS file (for the year 2005) and assigning the INM aircraft types via the OAG Aircraft Type Substitution List. Along with the COM.PRO preprocessed airport/runway data and the user case description (case year plus options), the list of aircraft types is compiled and written to the COM.HDR file. The "FT." line is an INM descriptor specifying that distances used in flight track descriptions are in feet. This line also could be specified as "NM." to reflect distances in nautical miles.

Sample COM.HDR file:

```
BEGIN.
SETUP:
TITLE <NASA ASAC HYPOTHETICAL CASE CREATED: 12/9/96 3:18:15
PM>
AIRPORT <COM>
ALTITUDE 96 TEMPERATURE 23 C
FT.
RUNWAYS
RW 36R-18L 50000 23000 TO 50000 35004 HEADING= 359
AIRCRAFT:
TYPES
AC 747400 CURVE=74E
AC DC9Q9 CURVE=DC9
```

Track Program

The Track program requires two pieces of information: (1) the user-specified set of efficient flight tracks (standard tracks for all runways except runway 36R) and (2) the COM.TRK preprocessed file, which lists all standard and efficient flight tracks in semi-INM format for COM airport.

The Track program copies the appropriate set of tracks for the user case from the COM.TRK file to the COM.TRX file.

Sample COM.TRX file:

```
"AIRPORT","COM"
"DEPARTURES",1
"36R",1
"ABATEMENT"
"2","STRAIGHT 5.28 LEFT 90 D 1.74 STRAIGHT 50"
"3","STRAIGHT 5.28 LEFT 20 D 1.74 STRAIGHT 50"
"4","STRAIGHT 1.97 RIGHT 20 D 1.74 STRAIGHT 50"
"5","STRAIGHT 1.97 RIGHT 60 D 1.74 STRAIGHT 50"
"6","STRAIGHT 1.97 RIGHT 270 D 1.74 STRAIGHT 50"
"NON-ABATEMENT"
"2","STRAIGHT 5.28 LEFT 90 D 1.74 STRAIGHT 50"
"3","STRAIGHT 5.28 LEFT 20 D 1.74 STRAIGHT 50"
"4","STRAIGHT 1.97 RIGHT 20 D 1.74 STRAIGHT 50"
"5","STRAIGHT 1.97 RIGHT 60 D 1.74 STRAIGHT 50"
"6","STRAIGHT 1.97 LEFT 90 D 1.74 STRAIGHT 50"
"ARRIVALS",1
"36R",1
"ABATEMENT"
"B","STRAIGHT 50"
"NON-ABATEMENT"
"B","STRAIGHT 50"
```

Noise Program

The Noise program creates tables of sound exposure level and effective perceived noise level (noise curves) versus distance in the INM format for aircraft types associated with the aircraft class to which the user requests decibel reductions.

It accomplishes this by first assigning INM aircraft types and classes to the OAG aircraft types in the COM.OPS preprocessed file (for the year 2005) via the INM "aircraft types and categories" database and the "OAG aircraft type substitution list."

The Noise program then copies all the noise curves from the INM noise database applicable to the user's case (long-haul, narrow-bodied departures and narrow-bodied arrivals for our sample case), modifies them by the user's reductions (i.e., 3 dB), and writes the modified noise curves to the NOISE.DAT file in the INM format.

Onecase Program

The Onecase program has two primary functions: (1) It is the engine for computing the number of annual average daily daytime, evening, and nighttime operations by INM aircraft type and stage length for the chosen runway use configuration and applicable flight tracks and (2) it compiles all INM operational data into an INM runstream file.

Onecase computes operations with the Flight Track Utilization by Aircraft Class preprocessed file (COM.UTI); the user-specified scalings by aircraft class (125 percent for long-haul and wide-bodied aircraft and 150 percent for long-haul and narrow-bodied aircraft); the INM aircraft types and categories database; the OAG aircraft type substitution list; and the preprocessed COM.OPS file (year 2005 portion). A sample calculation is described below.

With the help of the INM aircraft types and categories database and the OAG aircraft type substitution list, the program determines that, for the year 2005, the COM.OPS file contains the following annual operations:

- 4,240 long-haul, wide-body departures consisting of only INM aircraft type 747-400, stage length 5
- 624 long-haul, narrow-body departures consisting of only INM aircraft type DC9, stage length 3
- 4,240 wide-body arrivals consisting of only INM aircraft type 747-400
- 624 narrow-body arrivals consisting of only INM aircraft type DC9.

The user-specified scalings would be applied to these annual operations (rounding to the nearest operations for the sake of brevity):

- 4,240 x 1.25 = 5,300 long-haul, wide-body (747-400 stage length 5) departures
- 624 x 1.5 = 936 long-haul, narrow-body (DC9 stage length 3) departures
- 4,240 x 1.25 = 5,300 wide-body (747-400) arrivals
- 624 x 1.5 = 936 narrow-body (DC9) arrivals.

Sample NOISE.DAT file:

```
NOISE CURVES
NC DC9 6 BY 10 6 BY 10
EPNL
THRUSTS 3000 6000 8000 10000 12000 14000
200 92.6 98.4 102.7 107.2 111.8 116.8
400 88.4 94.2 98.5 103.2 107.8 112.9
630 85.1 90.9 95.3 100.0 104.7 109.9
1000 81.4 87.2 91.7 96.5 101.3 106.6
2000 75.4 81.2 85.8 90.6 95.7 101.2
4000 68.4 74.2 79.1 84.2 89.4 95.1
6300 63.1 68.9 74.0 79.5 85.0 91.0
10000 57.0 62.8 68.3 74.1 80.0 86.4
16000 49.5 55.3 61.3 67.6 74.0 81.0
25000 40.8 46.6 53.1 60.0 67.0 74.6
SEL
THRUSTS 3000 6000 8000 10000 12000 14000
200 88.6 93.8 98.3 103.0 107.8 113.1
400 84.8 90.0 94.6 99.2 104.1 109.4
630 81.9 87.1 91.7 96.5 101.4 106.8
1000 78.8 84.0 88.7 93.5 98.5 104.0
2000 73.8 79.0 83.7 88.6 93.6 99.1
4000 67.4 72.9 77.7 82.6 87.8 93.4
6300 63.0 68.2 73.1 78.1 83.3 89.0
10000 57.6 62.8 67.8 73.0 78.2 84.1
16000 51.2 56.4 61.6 66.9 72.4 78.4
25000 44.2 49.4 54.8 60.3 66.1 72.4
NC 747 5 BY 10 5 BY 10
EPNL
THRUSTS 8000 16000 24000 32000 40000
200 100.9 106.6 110.3 112.6 114.6
400 96.2 101.9 105.7 108.0 110.0
630 92.4 98.1 102.1 104.5 106.5
1000 87.8 93.5 97.9 100.5 102.5
2000 79.4 85.1 90.1 93.5 95.0
4000 71.4 77.1 83.2 86.5 88.5
6300 65.9 71.6 77.7 81.1 83.1
10000 59.7 65.4 71.6 75.0 77.0
16000 52.2 57.9 64.9 68.7 70.7
25000 43.3 49.0 57.1 61.4 63.4
SEL
THRUSTS 8000 16000 24000 32000 40000
200 96.3 100.3 103.4 105.8 107.8
400 91.8 95.8 99.1 101.4 103.4
630 88.3 92.3 95.7 98.1 100.1
1000 84.5 88.5 92.0 94.5 96.5
2000 78.4 82.4 86.2 88.9 90.9
4000 71.7 75.7 79.8 82.7 84.7
6300 66.9 70.9 75.2 78.2 80.2
10000 61.3 65.3 69.9 73.1 75.1
16000 54.7 58.7 63.7 67.1 69.1
25000 47.3 51.3 56.8 60.5 62.5
```

The COM.UTI file specifies that, for long-haul, wide-bodied aircraft, departure flight track 16 is used 82.1 percent during the daytime and 7.01 percent during the nighttime. For the long-haul, wide-body departures, departure flight track 16 would contain the following annual average daily operations:

- (5,300 departures/year x 0.821)/(365 days/year) = 12 daytime 747-400 stage length 5 departures per day
- (5,300 departures/year x 0.0701)/(365 days/year) = 1 nighttime 747-400 stage length 5 departures per day.

Similar calculations would be made for the DC9 stage length 3 departures on flight track 16 and for all 747-400 and DC9 arrivals on their respective flight tracks.

The program then combines the computed operations data with the

- COM.HDR file,
- COM.TRX file,
- NOISE.DAT file,
- COMMIL.HDR file, and
- COMMIL.FRQ file.

It generates an INM runstream file COM.INP. The COM.INP file is temporarily renamed FOR02.DAT for purposes of executing the INM.

Integrated Noise Model Version 4.11

The Input, Flight, and Compute modules of the INM are executed. The primary outputs are the FOR03.DAT and FOR33.DAT files, which contain the noise contours in a binary format.

PNTREAD2 Program

The PNTREAD2 program stands for "point read." It reads the binary format contour files generated by the INM and writes GIS noise contour files compatible with MapInfo.

Popcount Program

The Popcount program uses the "point read" files and the preprocessed census database files to compute the off-airport land acreage, numbers of dwellings, and population within each noise-exposure contour.

Computing Changes in Airfield Capacity and Delay

The savings program utilizes the database of airfield capacity and delay values to compute the differences in capacity and delay between the standard and more efficient runway use configurations. The results are written to the COM.SAV file.

Computing Time/Distance Savings Data

The Savings program uses the preprocessed data file of "time and distance values" for all standard and efficient flight tracks (for COM airport) and the user-specified set of efficient flight tracks (tracks on runway 36R only). The program computes the difference in time and distance between activation of the standard and efficient flight tracks and writes the results to the COM.SAV file, similar to the sample .SAV file shown previously.

Model Accuracy and Limitations

NIM relies on accurate input data, as do all computer models, and it makes as few assumptions and approximations as possible, given the intended use of the results. The primary usefulness of NIM is in its ability to model how *changes* in aircraft noise levels and/or flight procedures could affect flight efficiency and community noise impact. The assumptions and approximations noted below have been allowed because they speed processing time without diminishing, in our view the utility of the model for its intended purpose.

Overall, it must be noted that the noise calculations, while using the INM, are not sufficiently detailed to be useful for predicting noise impact at any given airport. LMI, and NASA strongly discourage users from exercising NIM to assess noise impacts at an airport for other than research purposes. The most recent version of the INM (currently version 5.1) as provided by the FAA, or the most recent version of its military counterpart NOISEMAP, as provided by the Department of the Air Force—always should be used as the primary tool for assessing or predicting aircraft noise impacts.

The definition of a long-haul flight as anything greater than 1,000 statute miles and the grouping of aircraft into long-haul versus short-haul categories is not as refined as most INM runstreams used for airport noise studies. However, the results of comparing one scenario to another are still valid for the level of detail available to most of the aviation industry and for research analysts exploring aircraft technologies.

Similarly, there are considerable differences in the noise characteristics of the various aircraft within the categories "narrow body" or "wide-body." New technologies are likely to be aimed at specific aircraft rather than broad categories, so users may want to apply individual aircraft noise reductions.

The INM itself has certain limitations due to the simplified treatment of how aircraft noise is generated and propagated in air and across varied terrain. Generally, the model is considered accurate within approximately one dB when groups of aircraft are considered. The accuracy diminishes as the aircraft travels farther away from the airport and as there are fewer aircraft in the mix.

CONCLUSIONS

The NIM provides analysts with a convenient tool bringing together four basic functions for studying airports:

- A noise modeling tool for aircraft operations
- Evaluation of the change in airfield capacity and estimated delay associated with using more efficient runway use patterns compared with standard noise-abatement configurations
- Evaluation of the time and distance savings associated with using more efficient flight tracks compared with existing noise-abatement flight tracks
- Accurate evaluation of changes in the off-airport acreage and numbers of people and homes impacted by noise resulting from user-defined changes in runway use, flight tracks, numbers of operations, and aircraft noise levels.

Bibliography

Burn, M., J. Carey, J. Czech, and E. R. Wingrove III. *The Flight Track Noise Impact Model*. NASA Contractor Report 201683, April 1997.

Wyle Research Report WR 96-19. *Aircraft Noise Reduction and Air Carrier Efficiency—Final Progress Repor*t. Wyle Laboratories, Arlington, VA, June 1996.

Appendix A
Flight Tracks and Noise Contours

In this appendix, we graphically display important data for the 16 airports included in the ASAC NIM.

Figure A-1. Atlanta International Flight Tracks and 1993 Noise Contours

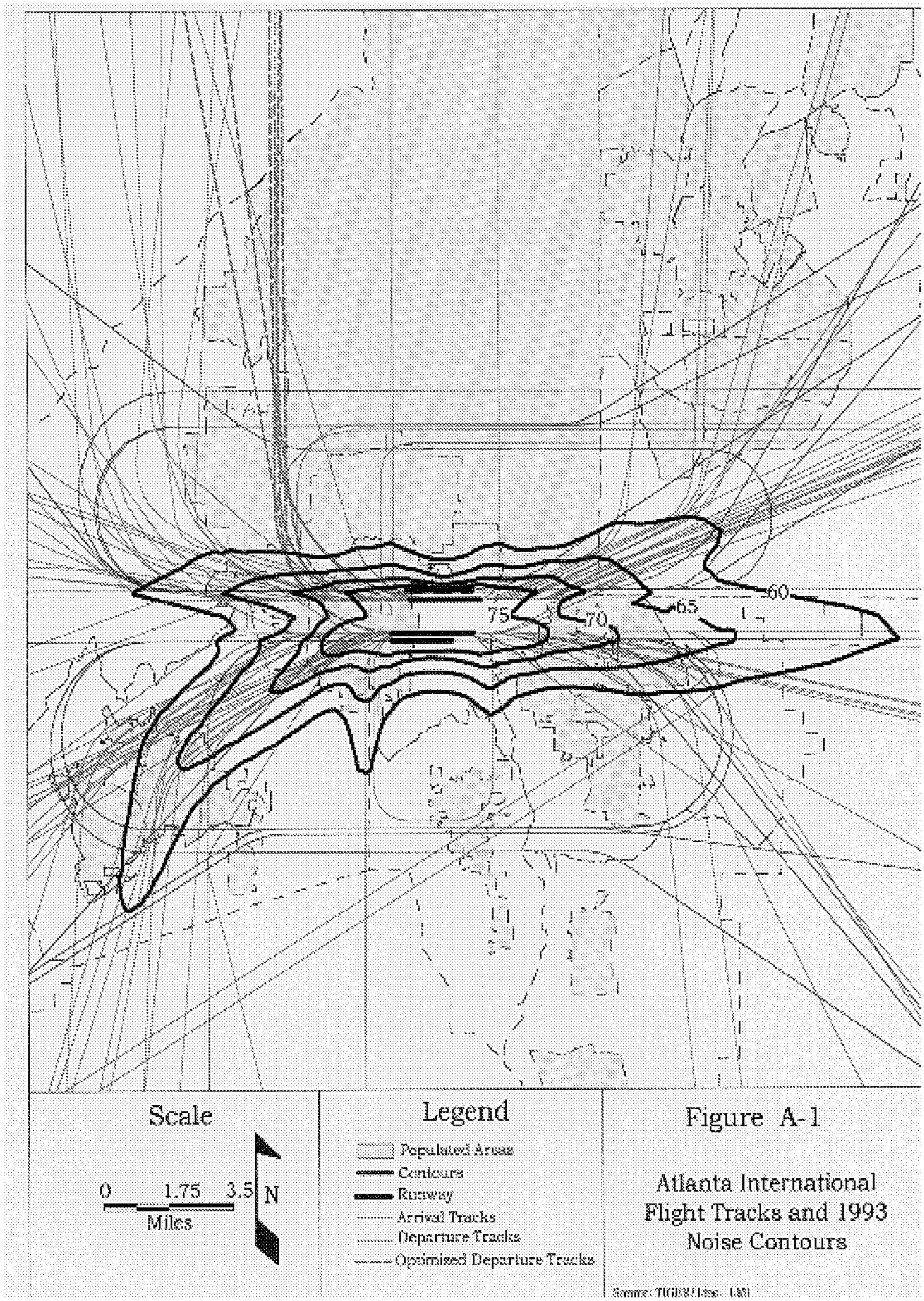


Figure A-2. Boston Logan International Airport Flight Tracks and 1993 Noise Contours

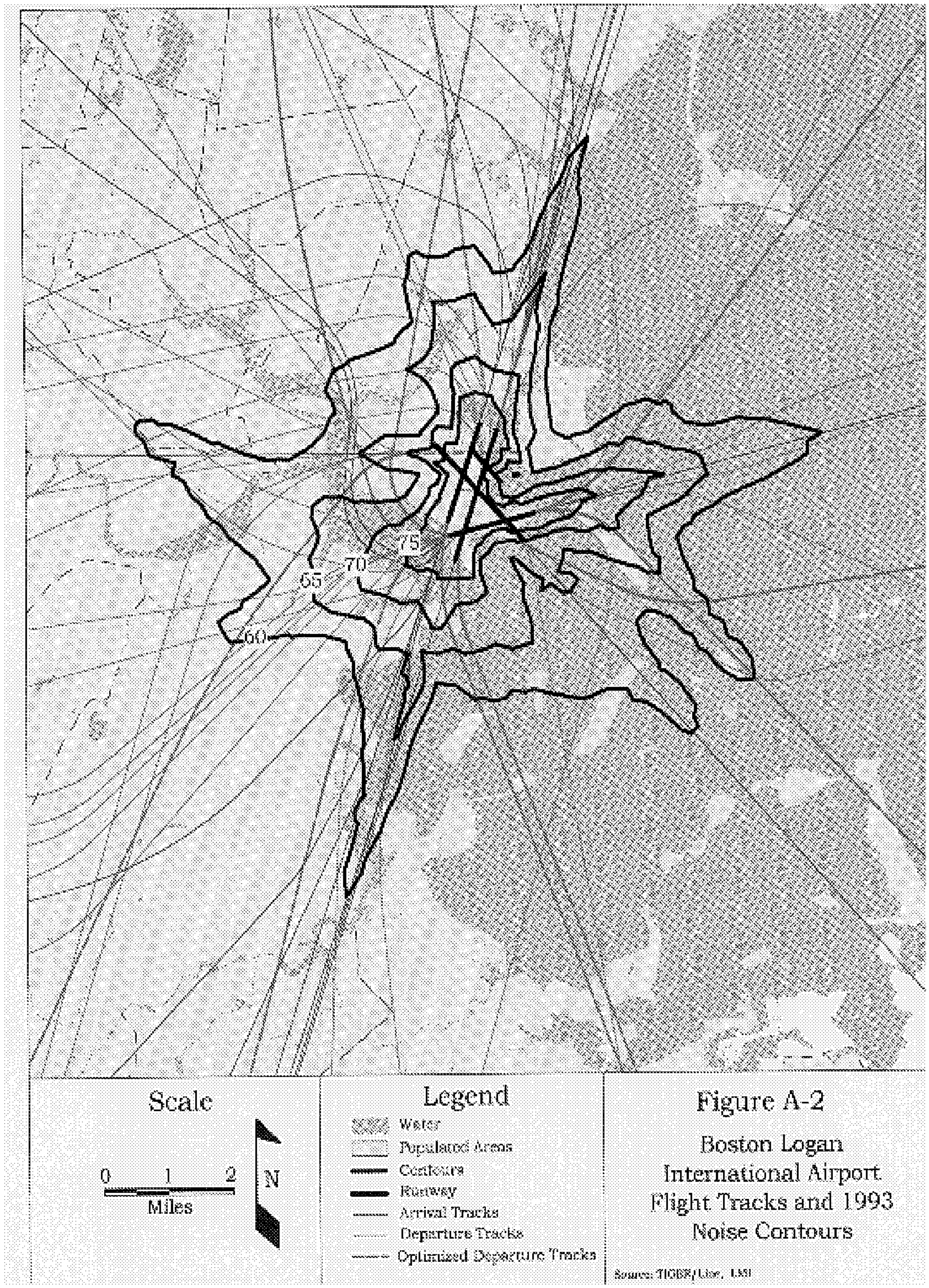


Figure A-3. Cincinnati-Northern Kentucky International Airport Flight Tracks and 1993 Noise Contours

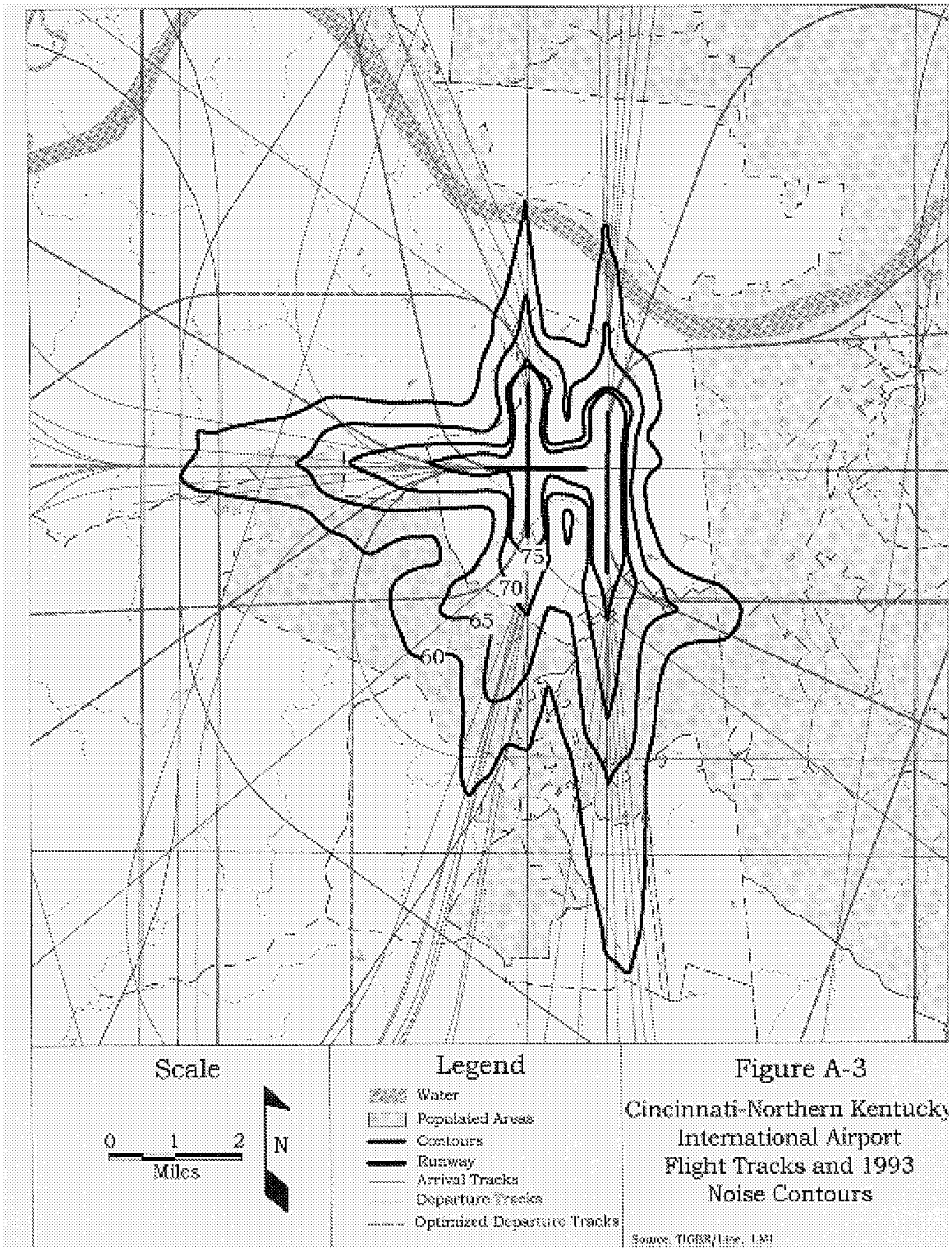


Figure A-4. Dallas/Ft. Worth International Flight Tracks and 1993 Noise Contours

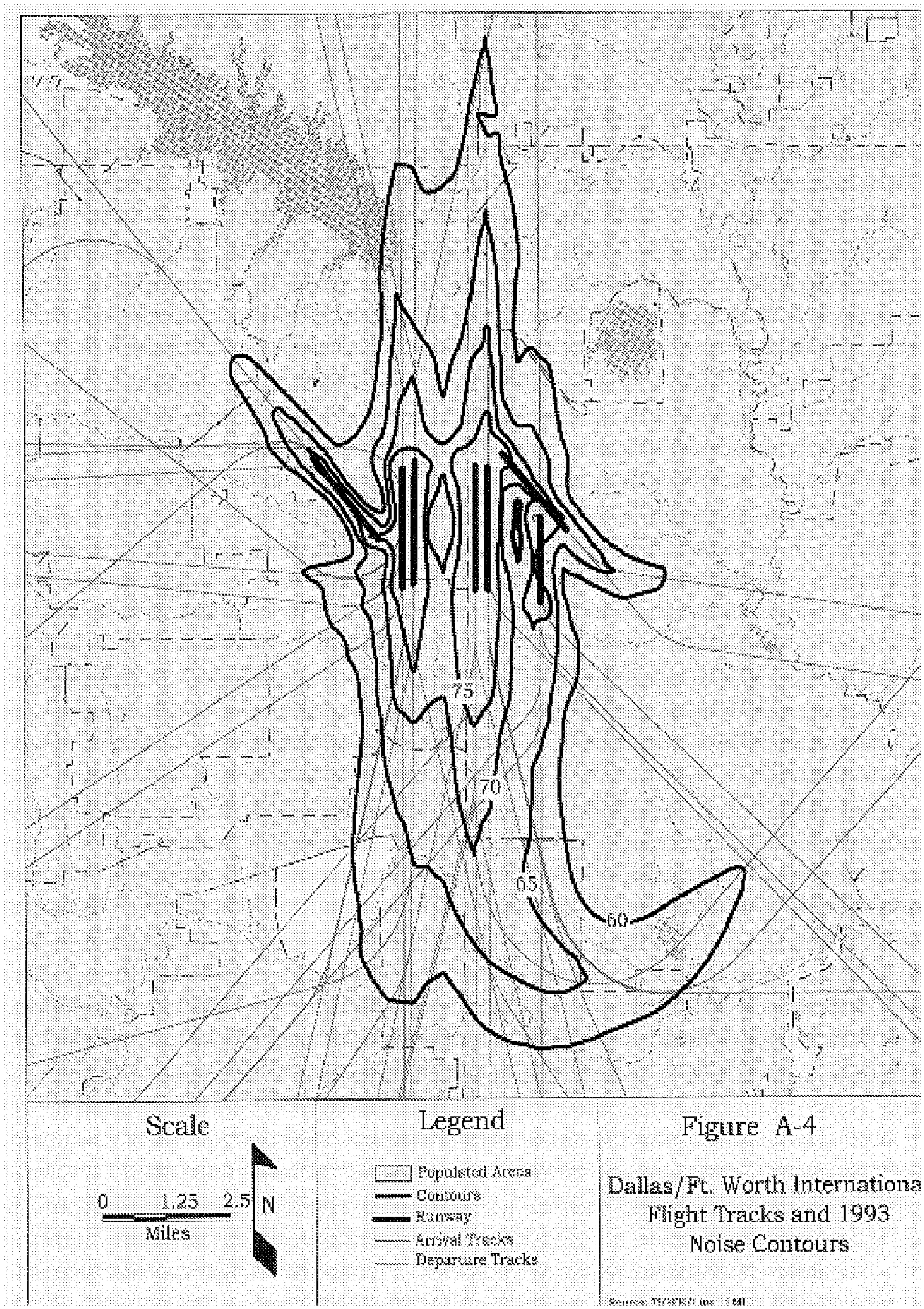


Figure A-5. Detroit Metropolitan Wayne County Airport Flight Tracks and 1993 Noise Contours

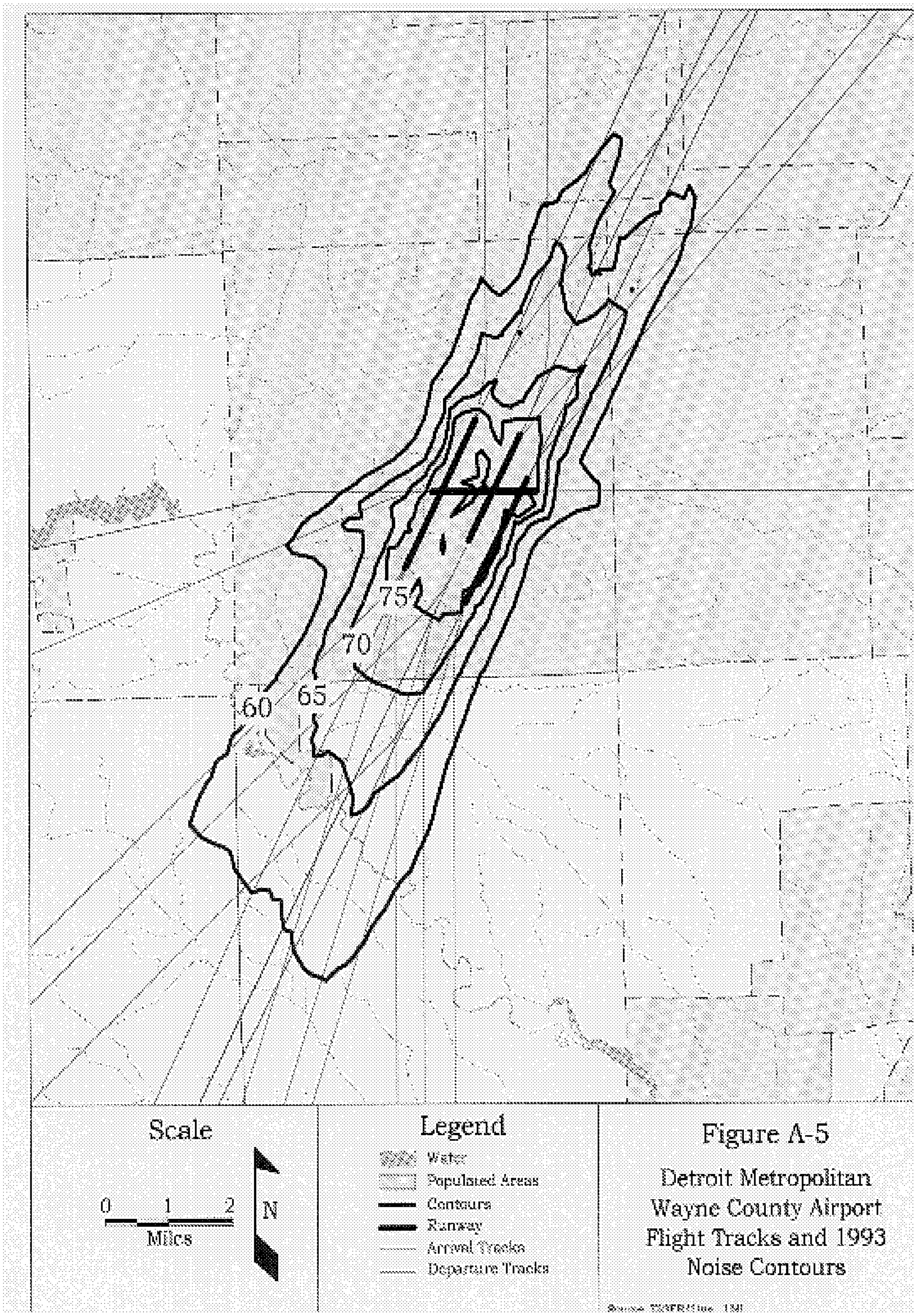


Figure A-6. Newark International Airport Flight Tracks and 1993 Noise Contours

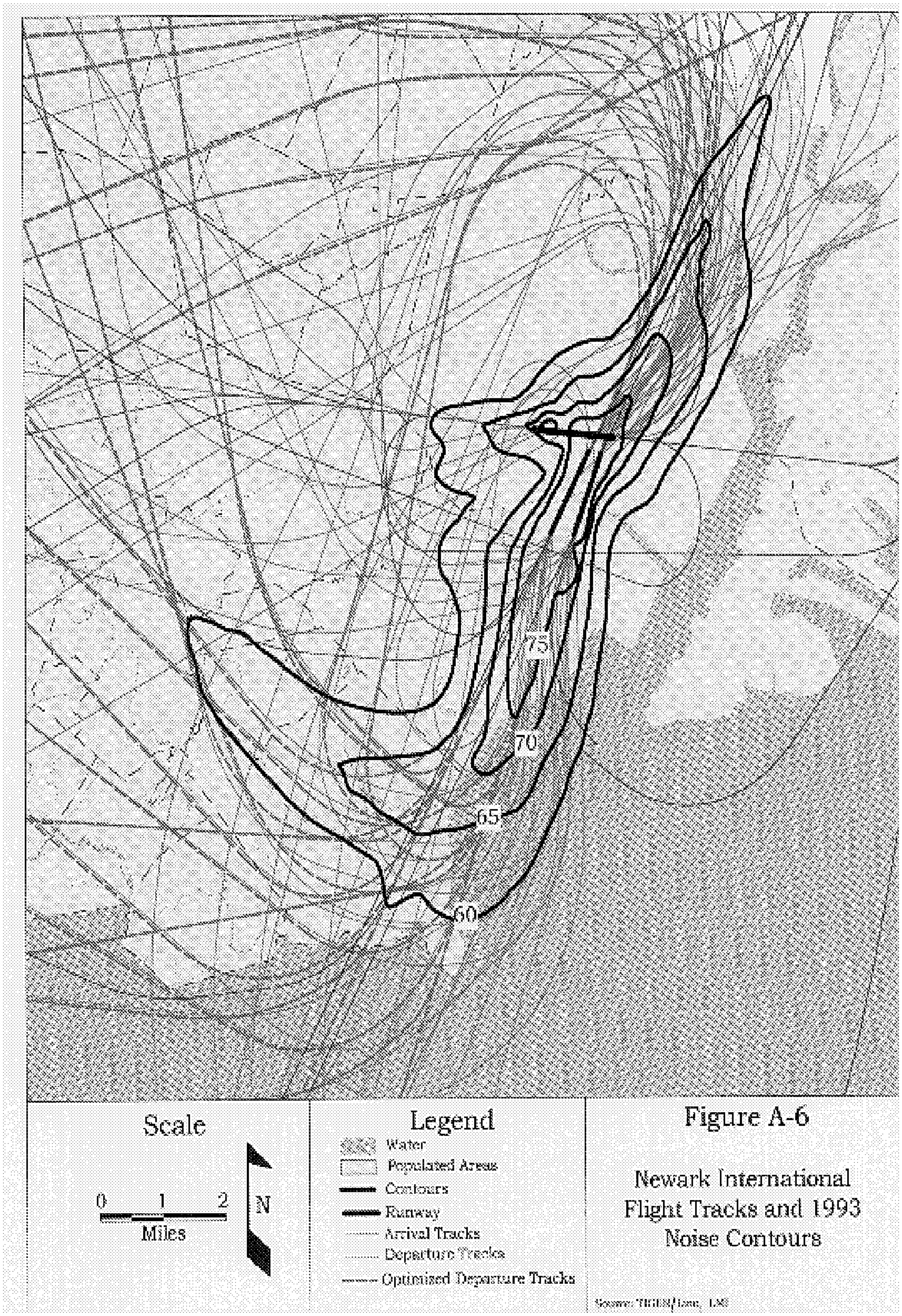


Figure A-7. Dulles International Airport Flight Tracks and 1993 Noise Contours

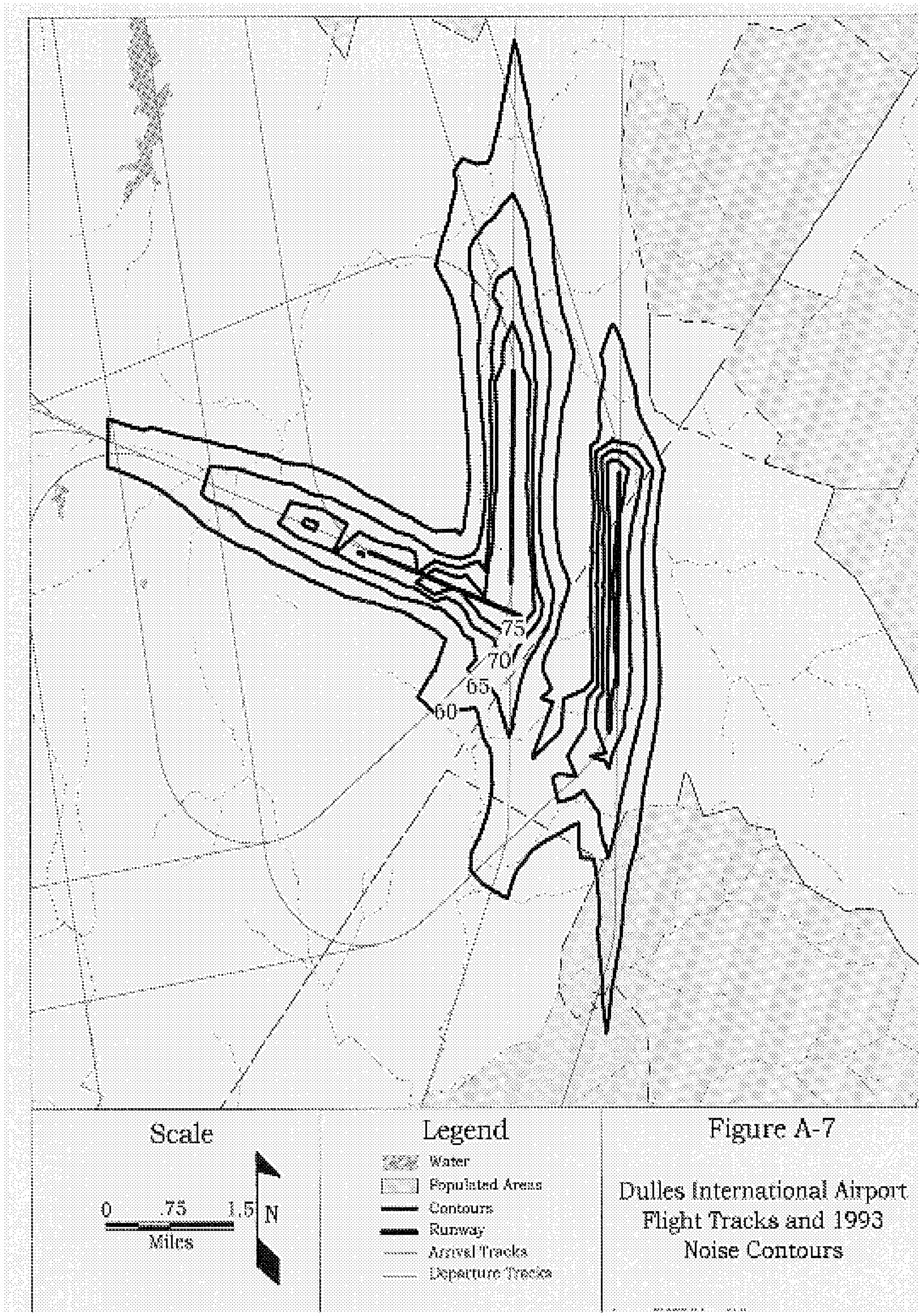


Figure A-8. John F. Kennedy International Flight Tracks and 1993 Noise Contours

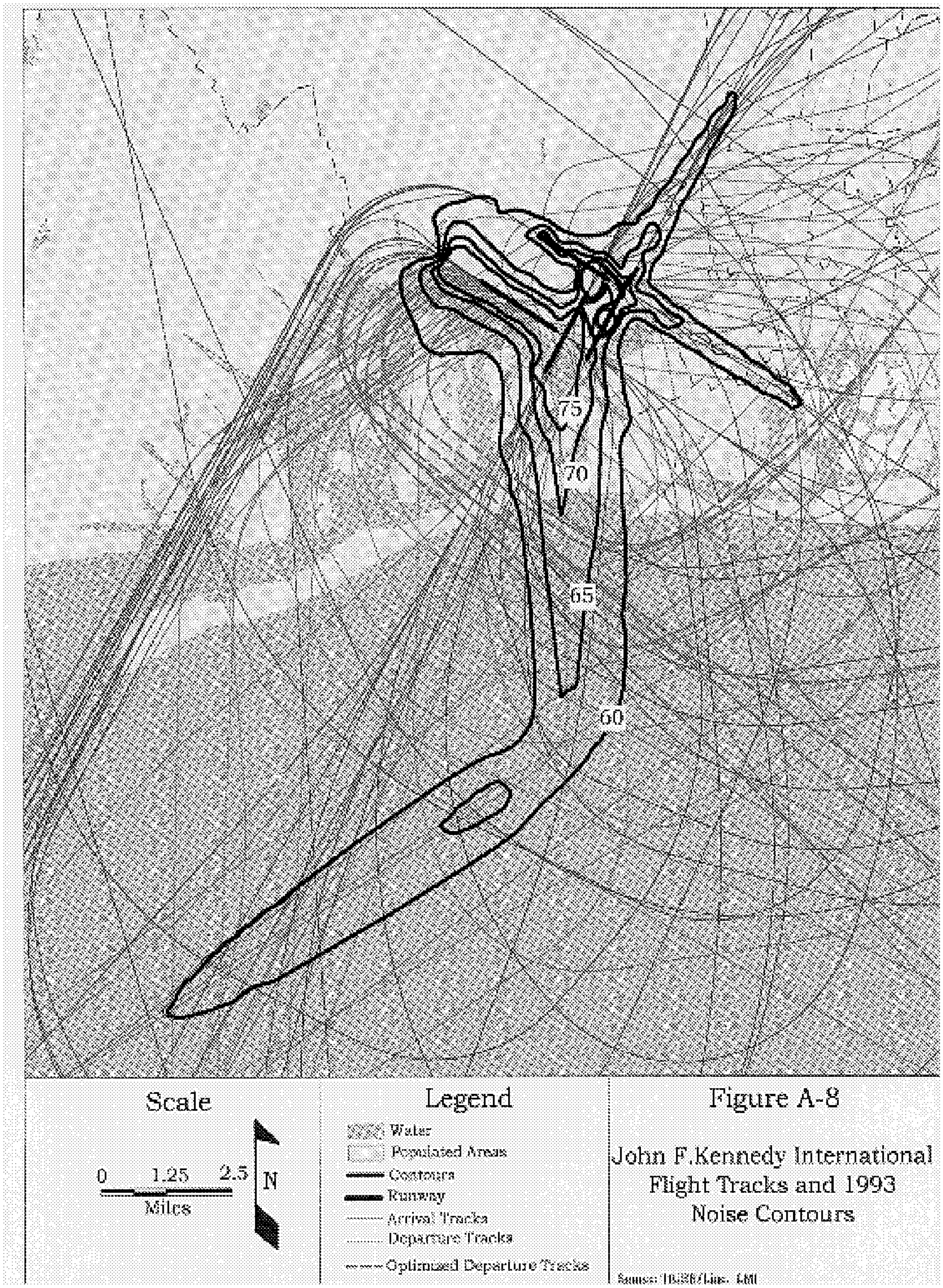


Figure A-9. Los Angeles International Flight Tracks and 1993 Noise Contours

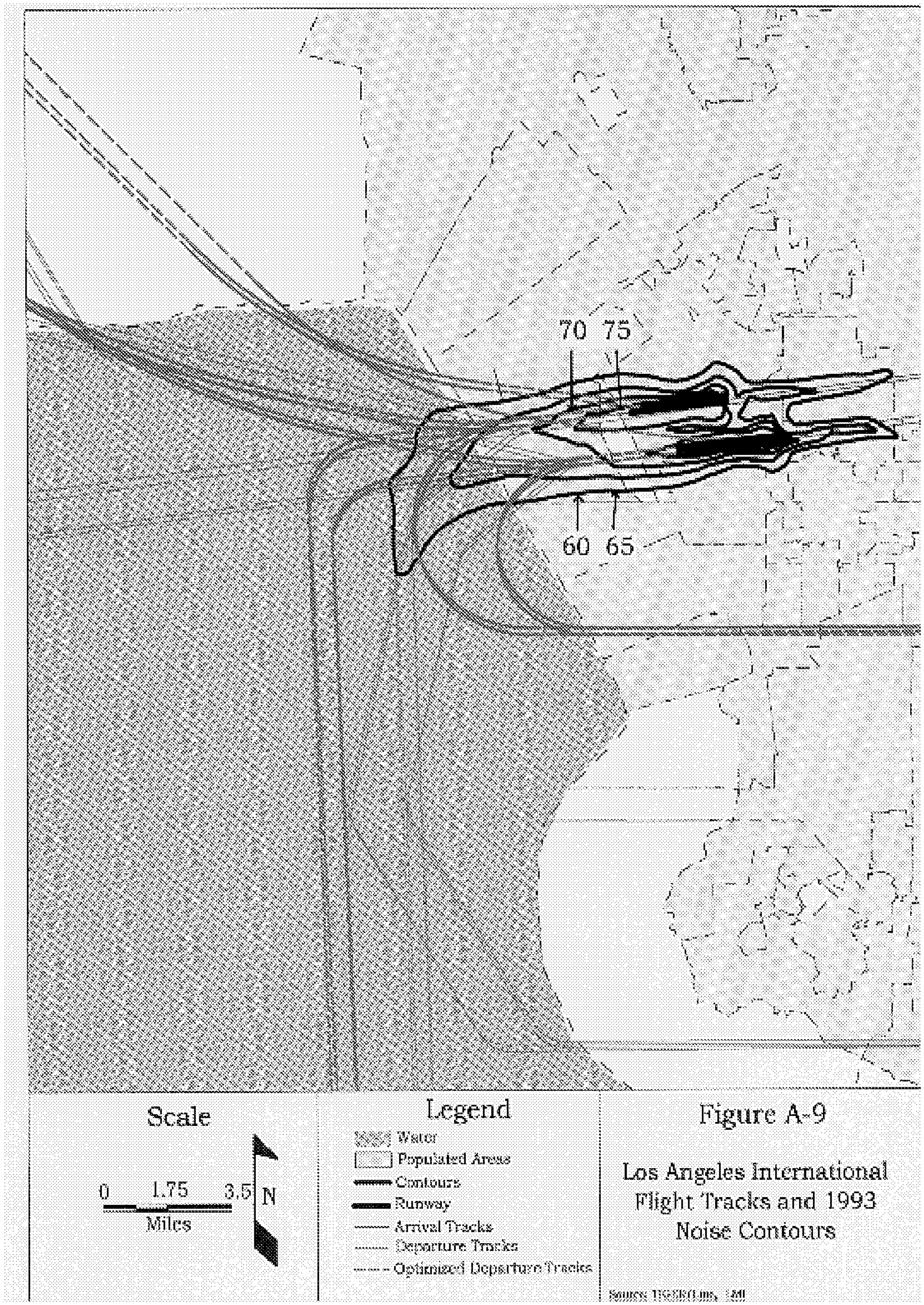


Figure A-10. La Guardia International Flight Tracks and 1993 Noise Contours

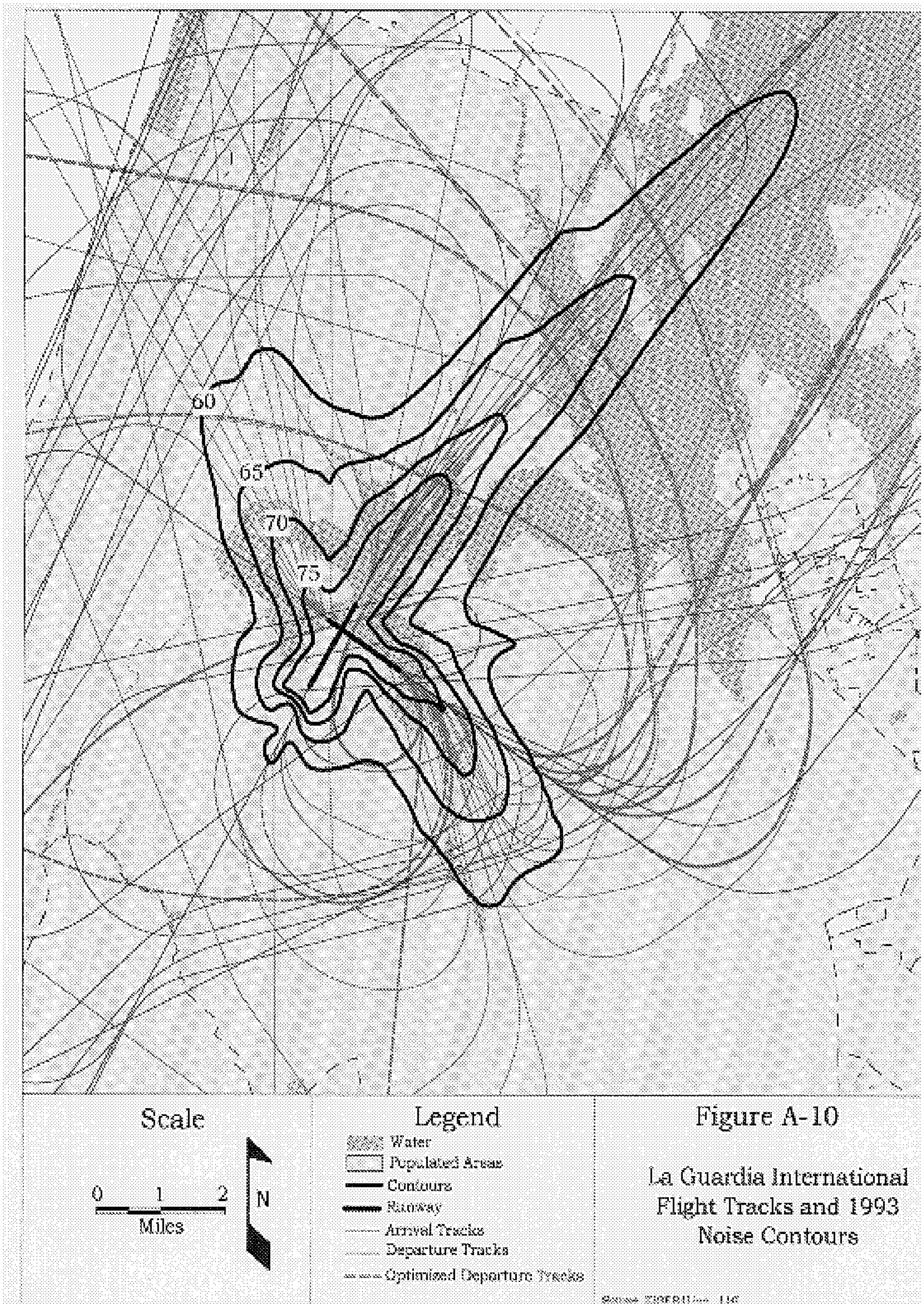


Figure A-11. Orlando International Airport Flight Tracks and 1993 Noise Contours

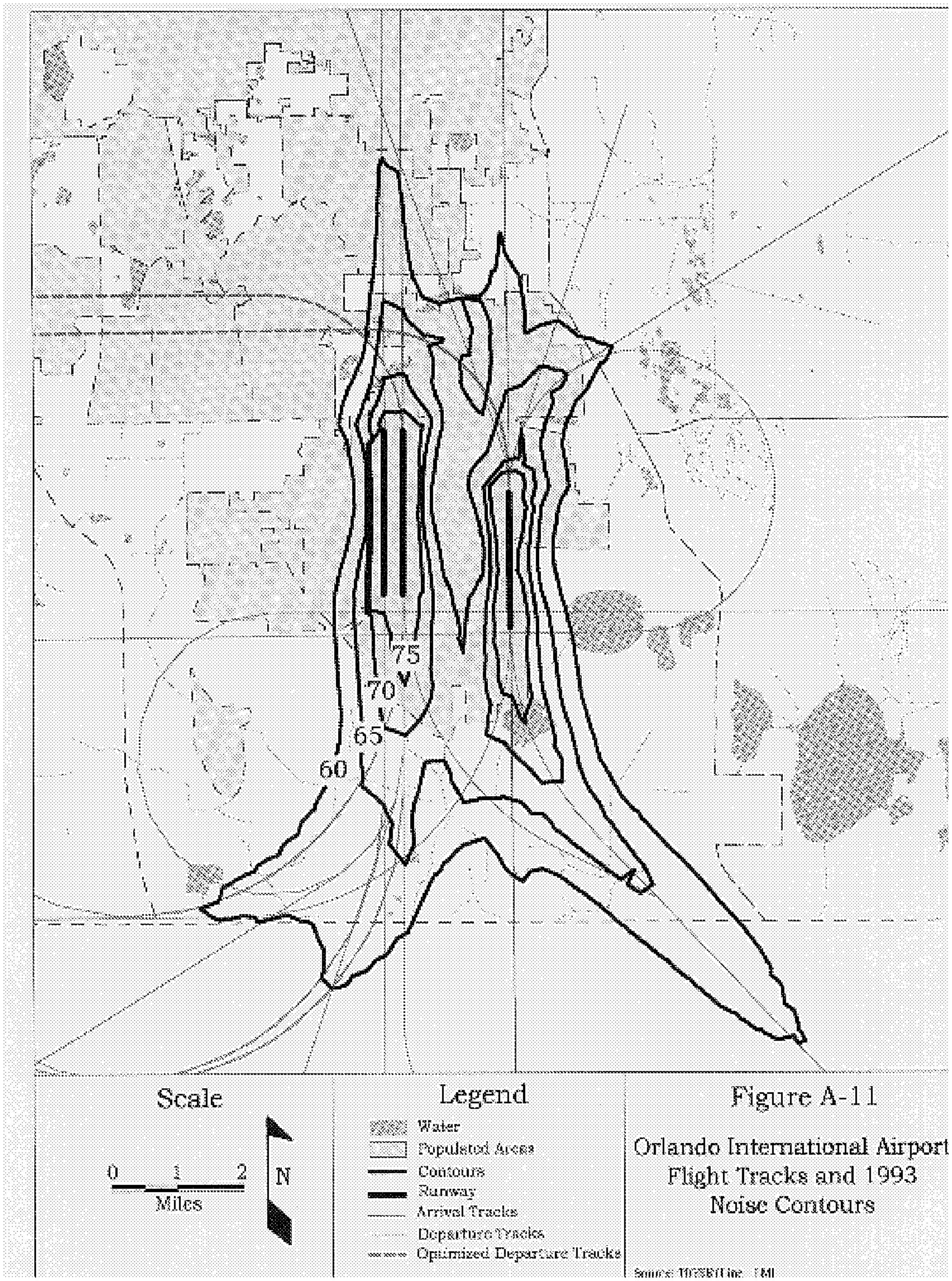


Figure A-12. Minneapolis-St. Paul International Airport Flight Tracks and 1993 Noise Contours

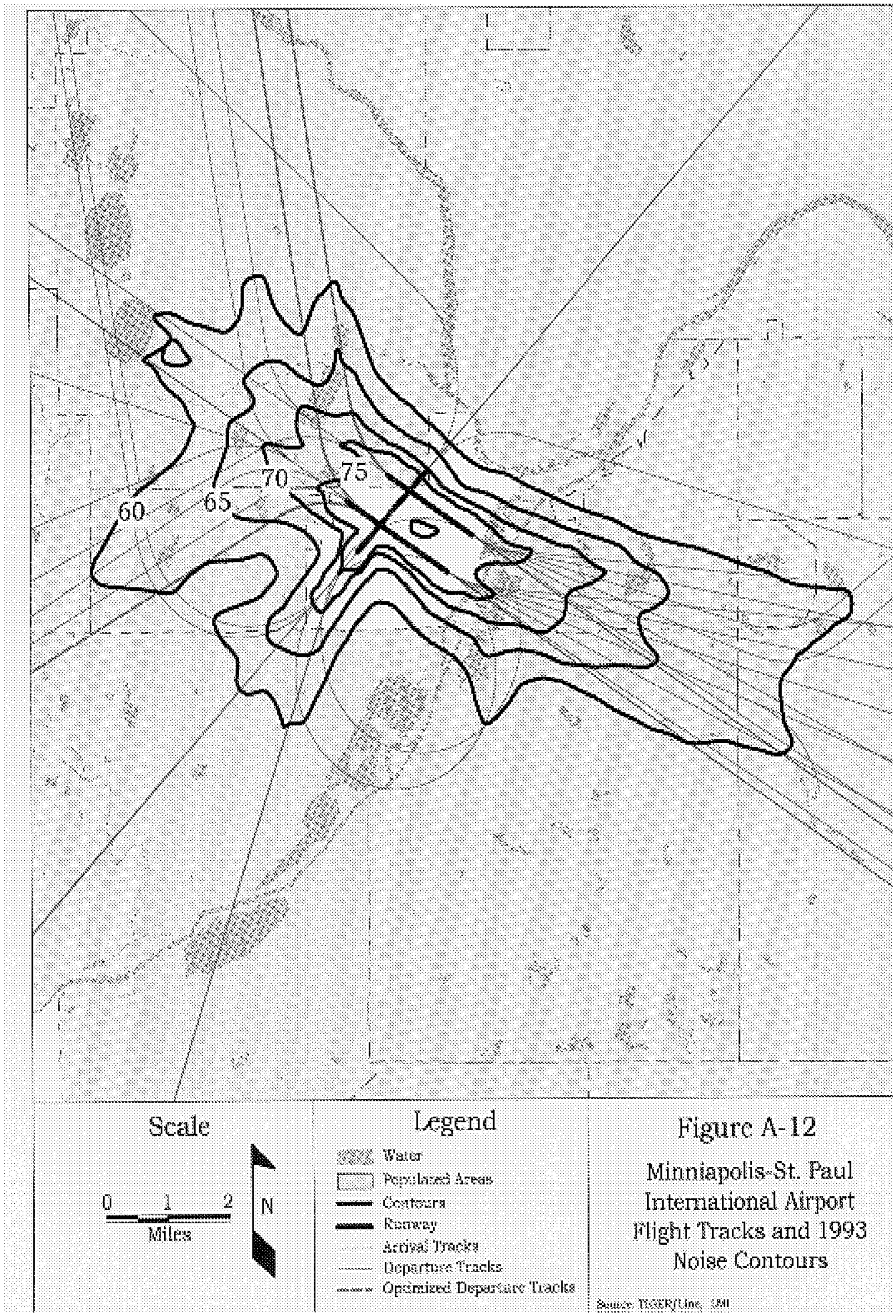


Figure A-13. Chicago O'Hare International Airport Flight Tracks and 1993 Noise Contours

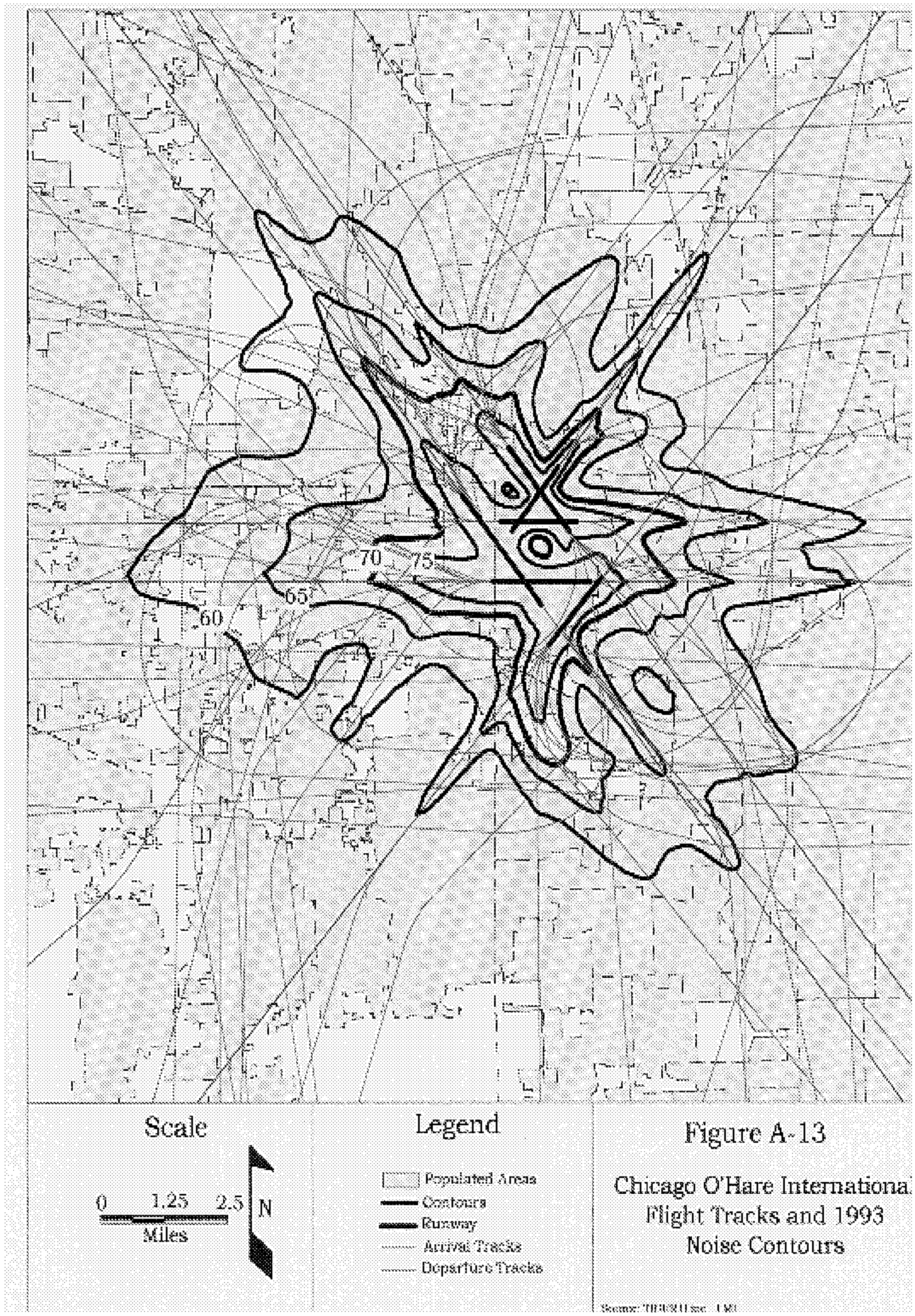


Figure A-14. Pittsburgh International Airport Flight Tracks and 1993 Noise Contours

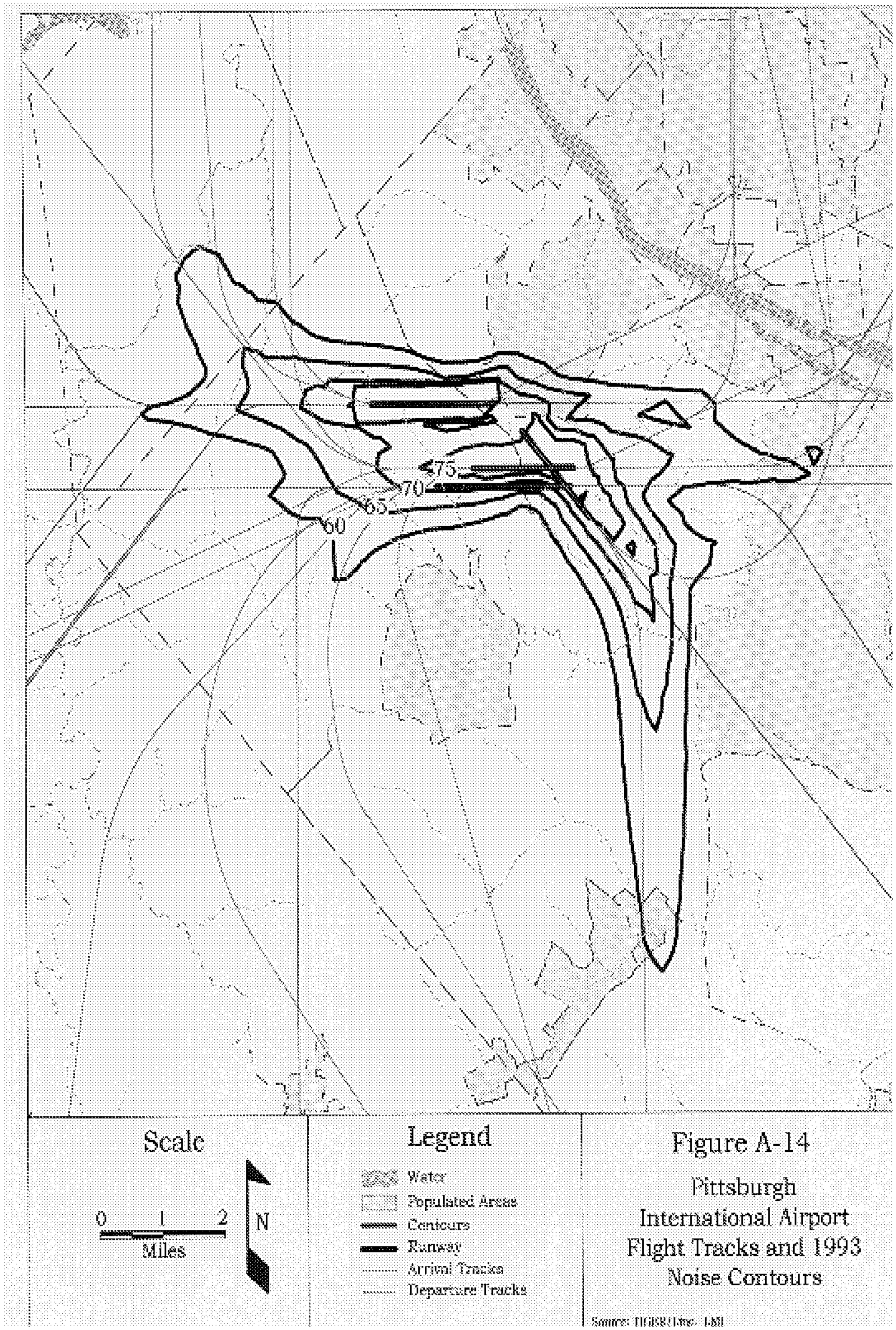


Figure A-15. Seattle-Tacoma International Airport Flight Tracks and 1993 Noise Contours

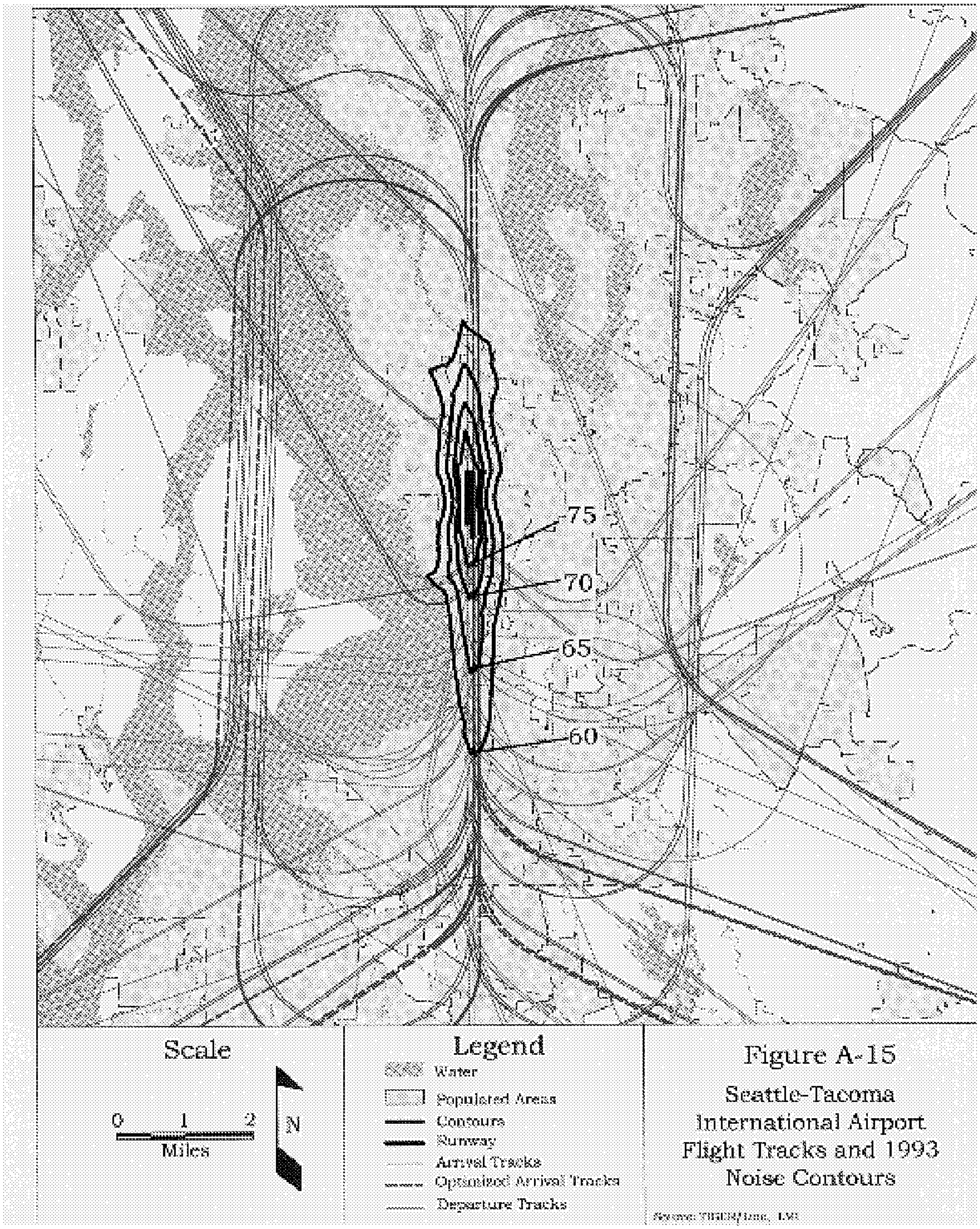
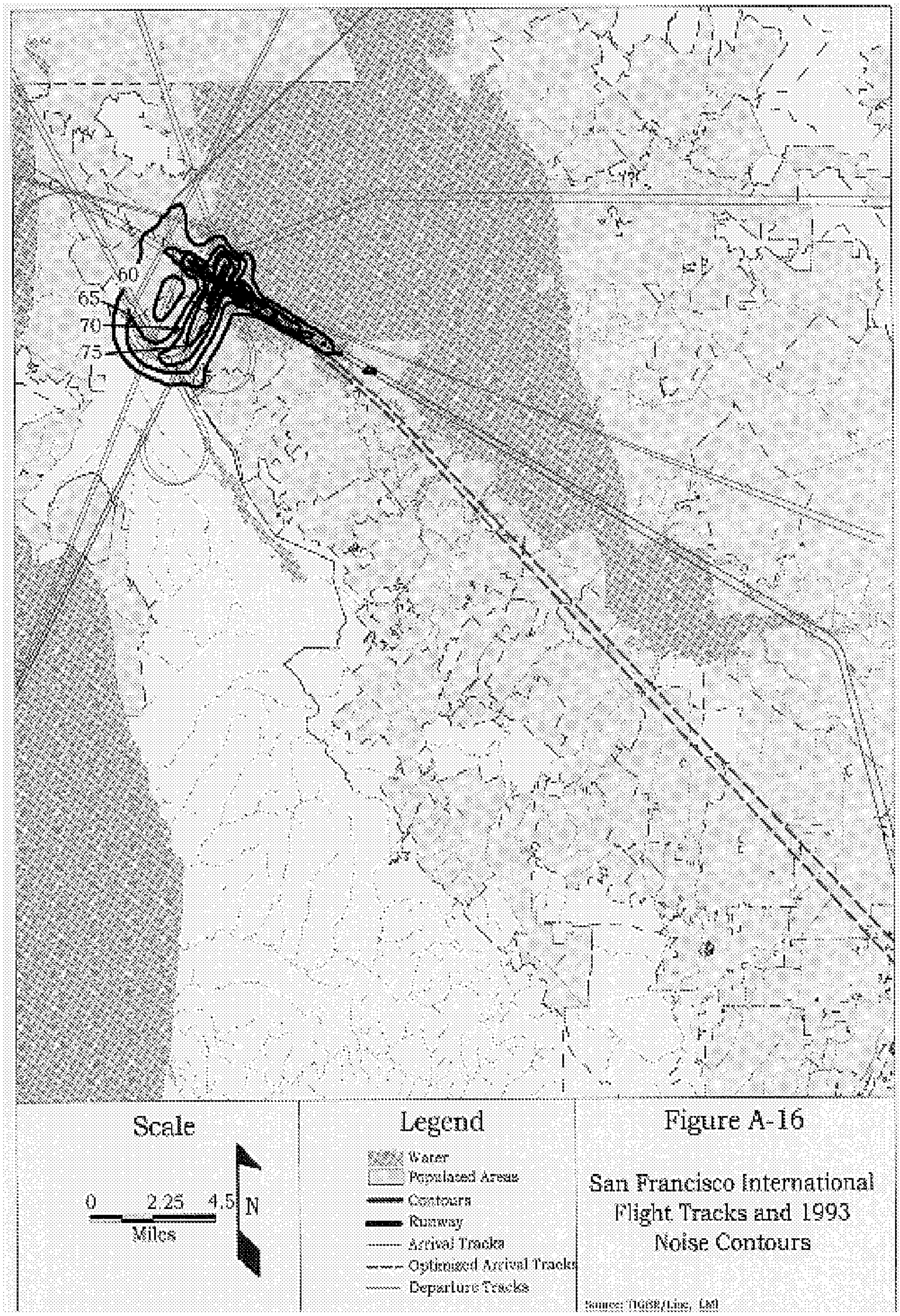


Figure A-16. San Francisco International Airport Flight Tracks and 1993 Noise Contours



Appendix B
Time and Distance Savings

Table B-1. Time and Distance Savings for Optimized Flight Tracks at Study Airports

Airport	Runway	Optimized flight track	Time saved (sec.)	Distance saved (nm)
ATL	26L	Z36X	16	1.92
	26L	Z5BY	14	1.65
	26L	Z5YB	31	3.64
	26L	Z6YB	19	2.19
	26L	Z7YB	25	2.89
	26L	Z8XB	7	0.82
	26L	Z5BY	14	1.65
	27R	Z32Y	20	2.39
BOS	04R	4RD1	41	5.3
	04R	4RD3	41	5.3
	04R	4RD4	41	5.3
	04R	4RD5	41	5.3
	09C	09D1	8	1.0
	09C	09D2	58	7.5
	09C	09D4	58	7.5
	15R	15D1	66	8.6
	15R	15D3	66	8.6
	15R	15D4	66	8.6
	15R	15D5	66	8.6
	22L	2LD1	74	9.6
	22L	2LD2	74	9.6
	22L	2LD3	74	9.6
	22L	2LD4	74	9.6
	22L	2LD5	74	9.6
	22R	2RD1	74	9.6
	22R	2RD2	74	9.6
	22R	2RD3	74	9.6
	22R	2RD4	74	9.6
	22R	2RD5	74	9.6
	27C	27N1	62	8.1
	27C	27N2	62	8.1

Table B-1. Time and Distance Savings for Optimized Flight Tracks at Study Airports (Cont.)

Airport	Runway	Optimized flight track	Time saved (sec.)	Distance saved (nm)
BOS (cont.)	27C	27N3	62	8.1
	27C	27N4	112	14.6
	27C	27N5	112	14.6
	27C	27N6	112	14.6
	27C	27S1	55	7.1
	27C	27S2	55	7.1
	27C	27S3	55	7.1
	27C	27S4	55	7.1
	27C	27S5	55	7.1
	27C	27S6	55	7.1
	33L	33D2	5	0.6
	33L	33D3	5	0.6
CVG	18L	DT10	93	12.0
	18L	DT12	93	12.0
	18L	DT15	38	4.9
	18L	DT19	93	12.0
	18R	DT21	49	6.3
	18R	DT2B	49	6.3
	18R	DT2M	49	6.3
	18R	DT2Q	49	6.3
	27	DT30	13	1.6
	27	DT31	13	1.6
	27	DT32	40	5.1
	27	DT33	3	0.4
	27	DT34	33	10.7
	27	DT35	55	7.1
	27	DT3C	55	7.1
	27	DT3D	13	1.6
	27	DT3M	13	1.6
	27	DT3N	3	0.4
	27	DT3P	13	1.6
	27	DT3Q	83	10.6
	36L	DT51	48	6.3
	36R	DT41	55	7.1
	36R	DT42	55	7.1
	36R	DT43	86	11.1
	36R	DT45	25	3.2

Table B-1. Time and Distance Savings for Optimized Flight Tracks at Study Airports (Con.t)

Airport	Runway	Optimized flight track	Time saved (sec.)	Distance saved (nm)
EWR	04L	4LD3	12	1.45
	04L	4LD4	10	1.15
	04L	4LD5	44	5.24
	04L	4LD6	13	1.56
	04L	4LD7	12	1.46
	04L	4LD8	14	1.70
	04R	4RD3	12	1.45
	04R	4RD4	10	1.15
	04R	4RD5	44	5.24
	04R	4RD6	13	1.56
	04R	4RD7	12	1.46
	04R	4RD8	14	1.70
	22L	2LD3	16	1.88
	22L	2LD4	10	1.22
	22L	2LD5	5	0.55
	22L	2LD6	10	1.21
	22L	2LD7	5	0.57
	22L	2LD8	11	1.31
	22L	2LDA	6	0.76
	22L	2LDO	2	0.27
	22L	2LDS	6	0.70
	22R	2RD3	16	1.88
	22R	2RD4	10	1.22
	22R	2RD5	5	0.55
	22R	2RD6	10	1.21
	22R	2RD7	5	0.57
	22R	2RD8	11	1.31
	22R	2RDA	6	0.76
	22R	2RDO	2	0.22
	22R	2RDS	6	0.70

Table B-1. Time and Distance Savings for Optimized Flight Tracks at Study Airports (Cont.)

Airport	Runway	Optimized flight track	Time saved (sec.)	Distance saved (nm)
JFK	31L	1LD1	17	2.27
	31L	1LD2	17	2.27
	31L	1LD3	21	2.91
	31L	1LD4	7	0.94
	31L	1LD5	21	2.86
	31L	1LD6	30	4.05
	31L	1LDB	13	1.82
	31L	1LDJ	13	1.78
	31R	1RD3	60	8.23
	31R	1RD4	13	1.80
	31R	1RD5	22	3.01
LAX	24L	M24L	29	3.03
	24L	P24L	114	11.85
	24L	V24L	68	7.05
	24R	M24R	29	3.03
	24R	P24R	114	11.85
	24R	V24R	68	7.05
	25L	M25R	45	4.68
	25L	P25L	117	12.12
	25L	V25L	68	7.05
	25R	M25R	45	4.68
	25R	P25R	117	12.12
	25R	V25R	68	7.05
LGA	13	13D1	23	2.78
	13	13D2	22	2.61
	13	13D3	9	1.04
	13	13D4	28	3.30
	13	13D5	71	8.43
	13	13D6	12	1.45
	13	13D7	32	22.00
	13	13D8	10	1.24
	13	13D9	10	1.22
	13	13DA	7	0.86
	13	13DB	5	0.61
	13	13DD	18	2.14
	13	13DG	6	0.76
	13	13DH	20	2.40

Table B-1. Time and Distance Savings for Optimized Flight Tracks at Study Airports (Cont.)

Airport	Runway	Optimized flight track	Time saved (sec.)	Distance saved (nm)
MCO	35L	10	39	5.16
	36R	6	41	5.47
MSP	29L	TR16	2	0.26
	29L	TR17	5	0.66
	29L	TR18	8	1.05
	29L	TR20	7	0.86
	29R	TR23	4	0.53
	29R	TR24	7	0.86
SEA	16L	JA04	22	2.94
	16L	JA12	30	4.00
	16R	JA54	22	2.94
	16R	JA62	30	4.00
	34L	JA55	95	12.77
	34L	JA57	31	4.10
	34L	JA59	43	5.81
	34L	JA61	20	2.64
	34L	JA63	20	2.65
	34L	JA65	62	8.30
	34R	JA05	47	6.30
	34R	JA07	33	4.50
	34R	JA09	46	6.21
	34R	JA11	46	6.25
	34R	JA13	23	3.05
	34R	JA15	62	8.30
SFO	28L	A1IN	10	1.24
	28R	A1NE	10	1.22

Appendix C

Airport Profiles

Table C-1. Airport Profiles

Name	Data
The William B. Hartsfield Atlanta International Airport	Airport,"ATL" Altitude,1026,"Temperature",16,"C" Runways,4 RW,"09R","27L",0,0,8700,0,92 RW,"09L","27R",0,1000,11700,1000,92 RW,"08R","26L",2740,5295,12650,5290,92 RW,"08L","26R",2076,6515,11610,6510,92
General Edward Lawrence Logan International Airport	Airport,"BOS" Altitude,15,"Temperature",59.0,"F" Runways,6 RW,"04R","22C",0,0,2966, 8285,35 RW,"04C","22L",474,1323,3440,9608,35 RW,"04L","22R",-545,2927,2028,10114,35 RW,"09C","27C",-145,1921,6589,3534,92 RW,"15R","33C",-1548,8613,5530,1504,151 RW,"15C","33L",-956,8017,5530,8017,151
Cincinnati/Northern Kentucky International Airport	Airport,"CVG" Altitude,890,"Temperature",12,"C" Runways,3 RW,"18R","36L",70,9500,0,0,180 RW,"09","27",-3265,4315,4530,4250,90 RW,"18L","36R", 6305,7745,6230,-2265,180
Dallas/Fort Worth International Airport	Airport,"DFW" Altitude,603,"Temperature",19,"C" Runways,7 RW,"34","16",13196,-1285,13196,6294,340 RW,"35R","17L",7815,-129,7816,10661,354 RW,"35L","17R",6406,-129,6406,10789,354 RW,"36R","18L",0,0,128,10789,354 RW,"36L","18R",-1154,128,-1153,10661,354 RW,"31L","13R",-3588,4366,-9609,10789,313 RW,"31R","13L",15374,5780,9225,11945,309

Table C-1. Airport Profiles (cont.)

Name	Data
Detroit Metropolitan Wayne County Airport	Airport,"DTW" Altitude,639,"Temperature",48.6,"F" Runways,4 RW,"09","27",2180,5380,10880,5380,094 RW,"03L","21R",0,0,5830,10490,034 RW,"03C","21C",5280,1940,9500,9370,034 RW,"03R","21L",5020,-2460,10120,6260,034
Newark International Airport	Airport,"EWR" Altitude,18,"Temperature",13,"C" Runways,6 RW,"04R","22L",0,0,3996,8398,39 RW,"03R","21L",-451,1904,3485,7323,39 RW,"04L","22R",-1620,1637,2823,8122,39 RW,"03L","21R",-1301,2305,2634,7725,39 RW,"11","29",-1881,9081,4899,8553,108 RW,"10","28",-1881,9081,4601,8577,108
Washington Dulles International Airport	Airport,"IAD" Altitude,313,"Temperature",60,"F" Runways,3 RW,"01L","19R",0,0,140,11499,10 RW,"01R","19L",6632,-5581,6773,5918,10 RW,"12","30",-8791,1689,578,-1807,120
John F. Kennedy International Airport	Airport,"JFK" Altitude,13,"Temperature",13,"C" Runways,7 RW,"04L","22R",0,0,5805,9755,44 RW,"05L","23R",0,0,4260,7158,44 RW,"04R","22L",4222,1241,8518,8459,44 RW,"13L","31R",-1255,13035,7338,7920,134 RW,"14L","32R",-405,12528,6458,8444,134 RW,"13R","31L",-8643,9635,3879,2183,134 RW,"14R","32L",-6404,8303,1023,3883,134

Table C-1. Airport Profiles (cont.)

Name	Data
Los Angeles International Airport	Airport,"LAX" Altitude,126",TEMPERATURE",17,"C" Runways,8 RW,"06L","24R",-3649,5566,4790,6611,69 RW,"06R","24L",-4959,4689, 4925,5971,69 RW,"07L","25R",-68,708,11570,2159,69 RW,"07R","25L",0,0,11503,1416,69 RW,"08L","26R",-68,708,10984,2087,69 RW,"08R","26L",0,0,10920,1345,69 RW,"06C","24C",-5296,5002,4834,6254,69 RW,"07C","25C",-34,354,11537,1787,69
La Guardia Airport	Airport,"LGA" Altitude,"22,"Temperature",13,"C" Runways,3 RW,"04","22",0,0,3701,5942,45 RW,"13","31",1572,4792,7514,1091,135 RW,"14","30",1572,4792,7365,1184,135
Orlando International Airport	Airport,"MCO" Altitude,96,"Temperature",23.0,"C" Runways,3 RW,"36L","18R",0,0,0,12204,359 RW,"36R","18L",1500,0,1500,12204,359 RW,"35L","17R",10040,-2500,9950,7500,359
Minneapolis–St. Paul International Airport	Airport,"MSP" Altitude,841,"Temperature",60,"F" Runways,4 RW,"04","22",0,0,5140,5120,41 RW,"11R","29L",-880,3790,7700,-1450,118 RW,"11L","29R",2580,5610,9550,1350,118 RW,"04C","22C",0,0,5950,5900,41
Chicago O'Hare International Airport	Airport,"ORD" Altitude,668,"Temperature",10,"C" Runways,6 RW,"04L","22R",0,0,4770,5787,41 RW,"04R","22L",3938,-10327,9286,-4283,43 RW,"09L","27R",-1209,814,6758,855,91 RW,"09R","27L",-1935,-4610,8205,-4590,91 RW,"14L","32R",-397,7568,6033,-95,141 RW,"14R","32L",-5228,3198,3129,-6759,141

Table C-1. Airport Profiles (cont.)

Name	Data
Greater Pittsburgh International Airport	Airport,"PIT" Altitude,18,"Temperature",82.7,"F" Runways,5 RW,"10L","28R",0,0,10500,0,100 RW,"10C","28C",8773,-4309,16812,-4311,100 RW,"10","28",8773,-4309,17412,-4311,100 RW,"10R","28L",5622,-5503,17122,-5503,100 RW,"14","32",12973,-1855,18758,-7526,140
Seattle–Tacoma International Airport	Airport,"SEA" Altitude,430,"Temperature",11,"C" Runways,2 RW,"34L","16R",0,0,0,9425,338 RW,"34R","16L",800,-2475,800,9425,338
San Francisco International Airport	Airport,"SFO" Altitude,11,"Temperature",16,"C" Runways,4 RW, "10L","28R",0,0,11689,-2061,100 RW, "10R","28L",1113, -1008,11552,-2849,100 RW, "01L","19R",5643, -5391,6859,1503,10 RW, "01R","19L",6226, -6589,7771,2176,10

Appendix D

Data Input Screens

Figure D-1. NIM Home Page

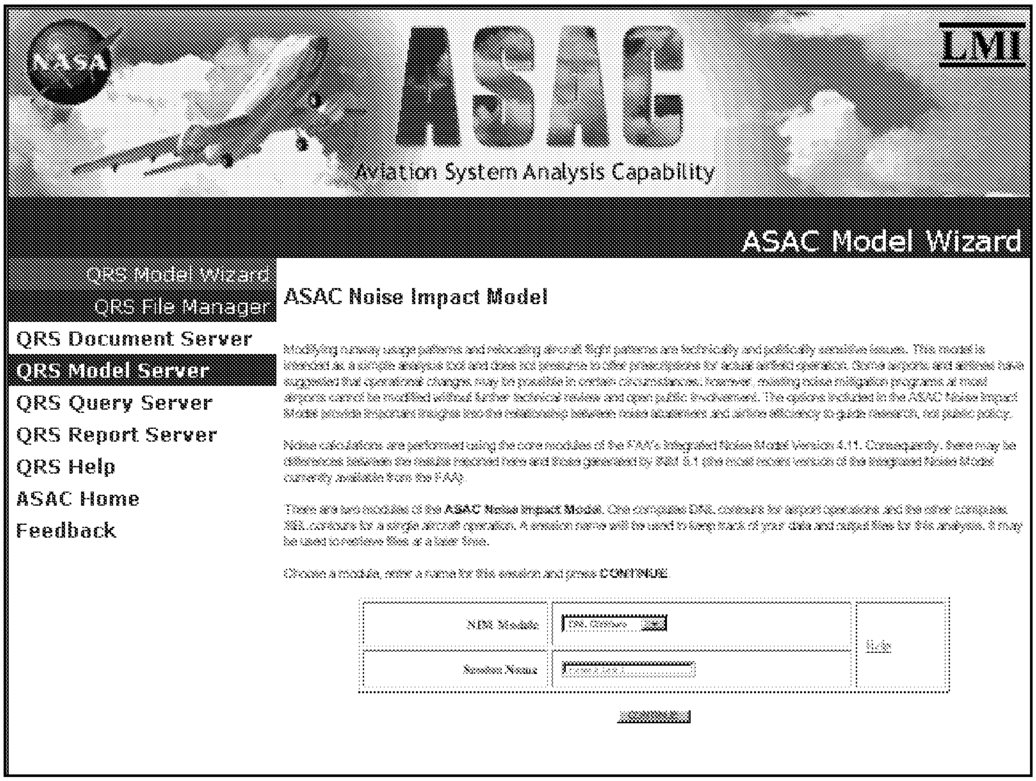


Figure D-2. NIM Scenario File Locator

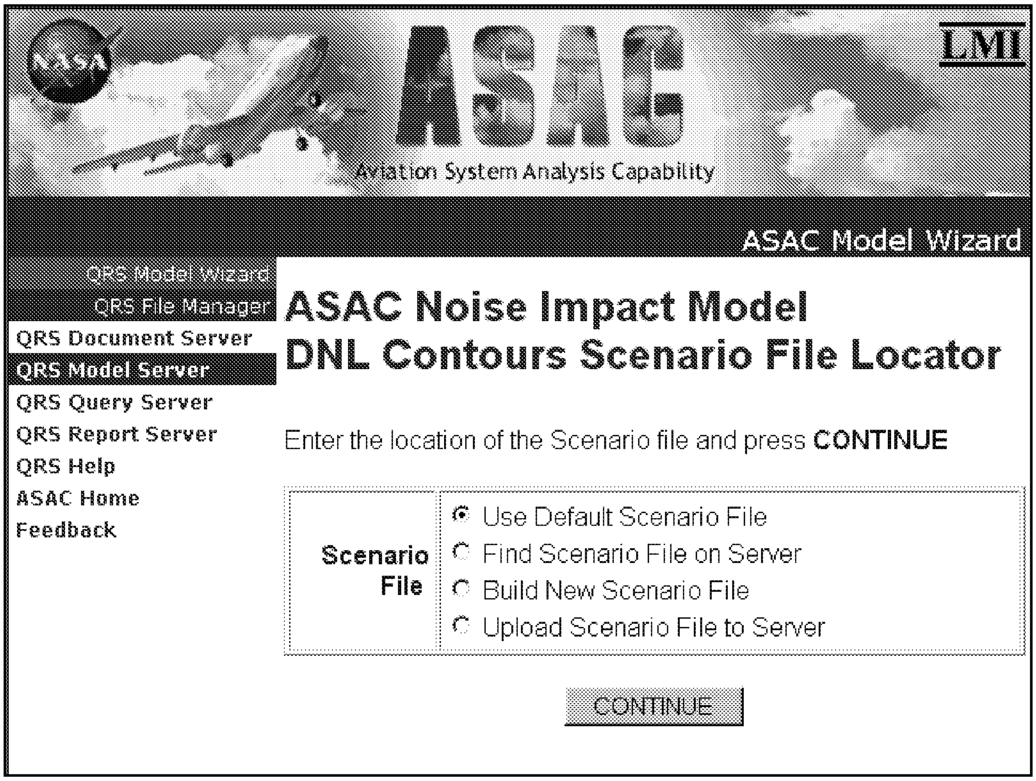


Figure D-3. Airport Selector

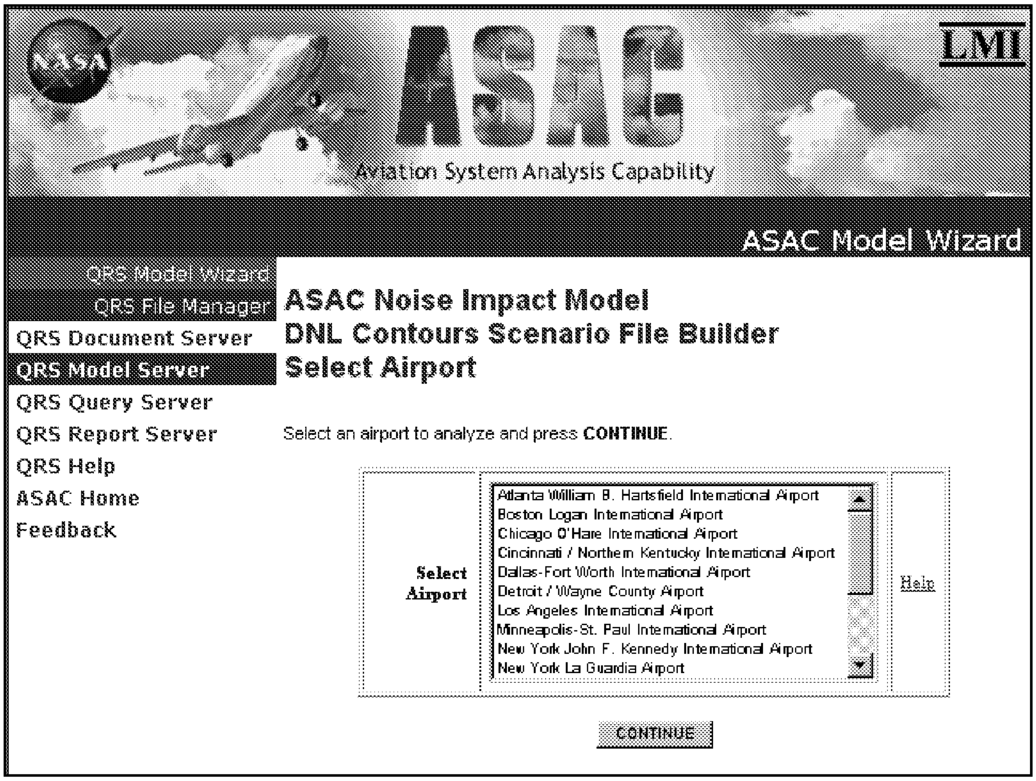


Figure D-4. Global Parameters (Part 2)

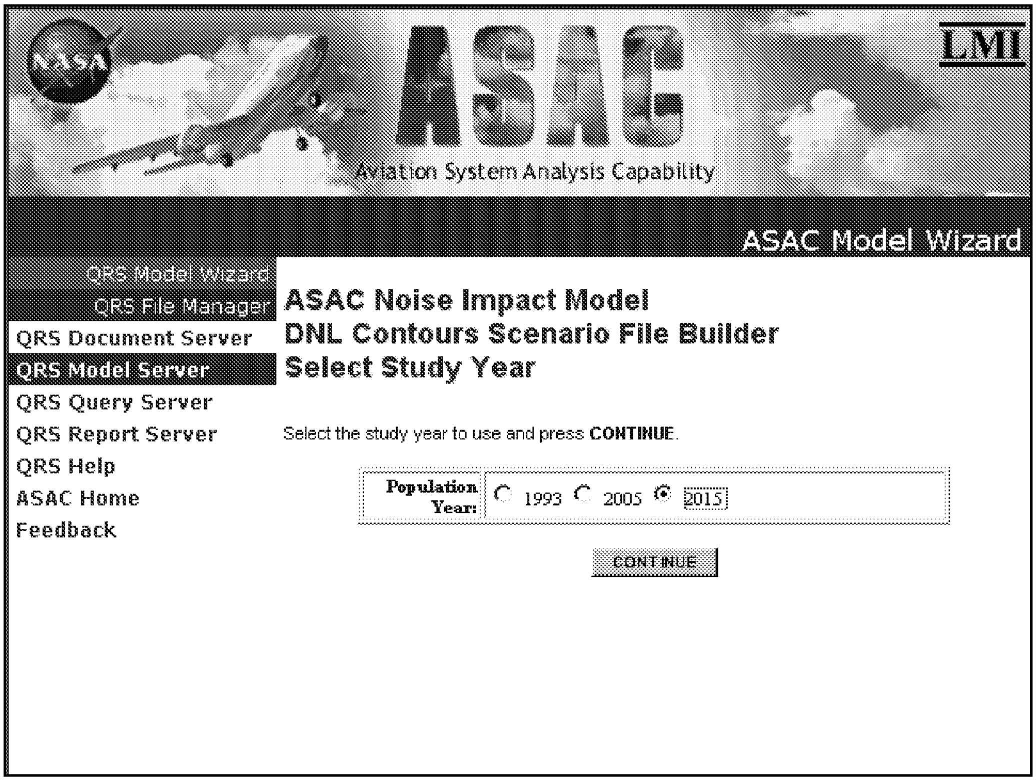


Figure D-5. Aircraft Operations Scaling

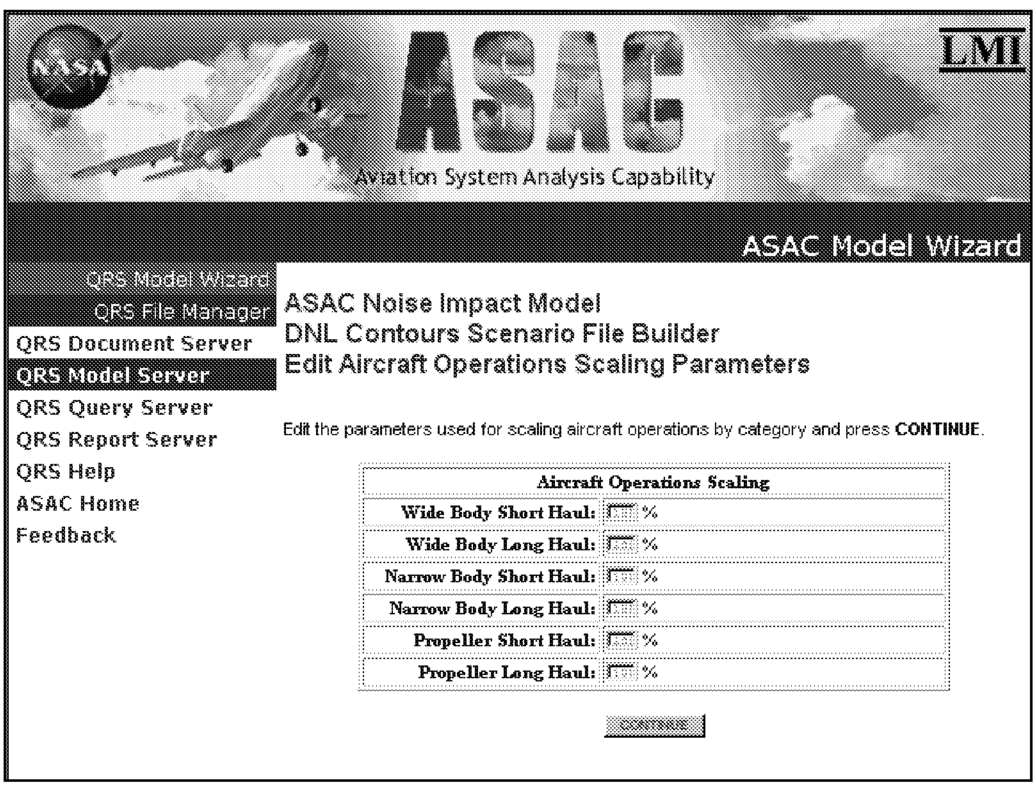


Figure D-6. Flight track Optimization

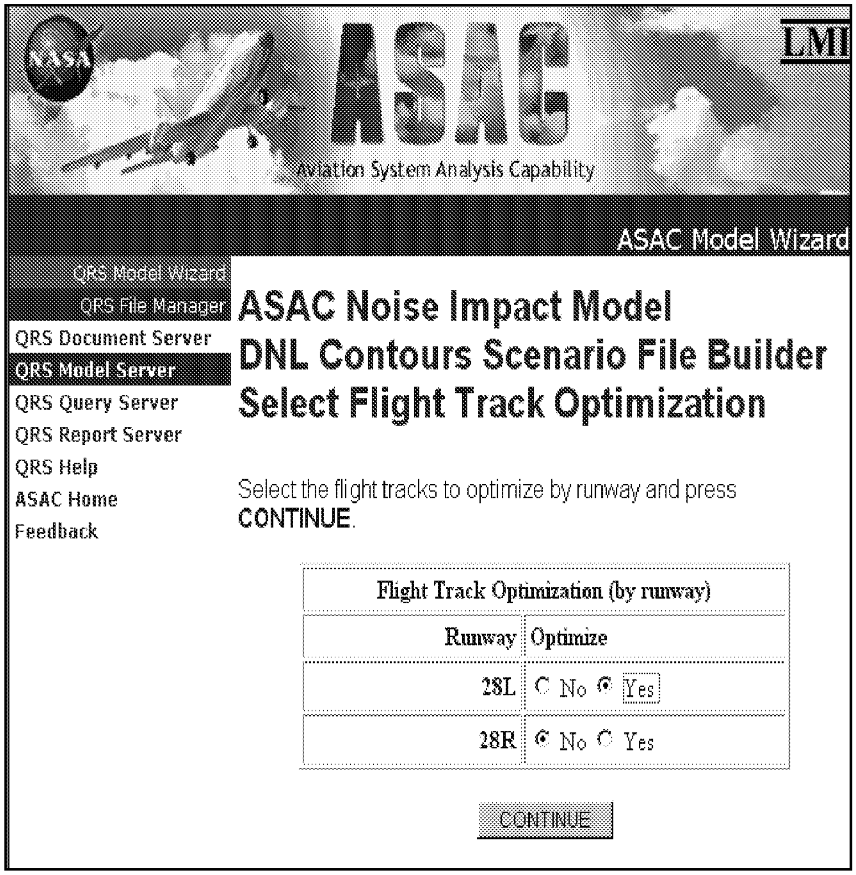


Figure D-7. Alternative Runway Utilization

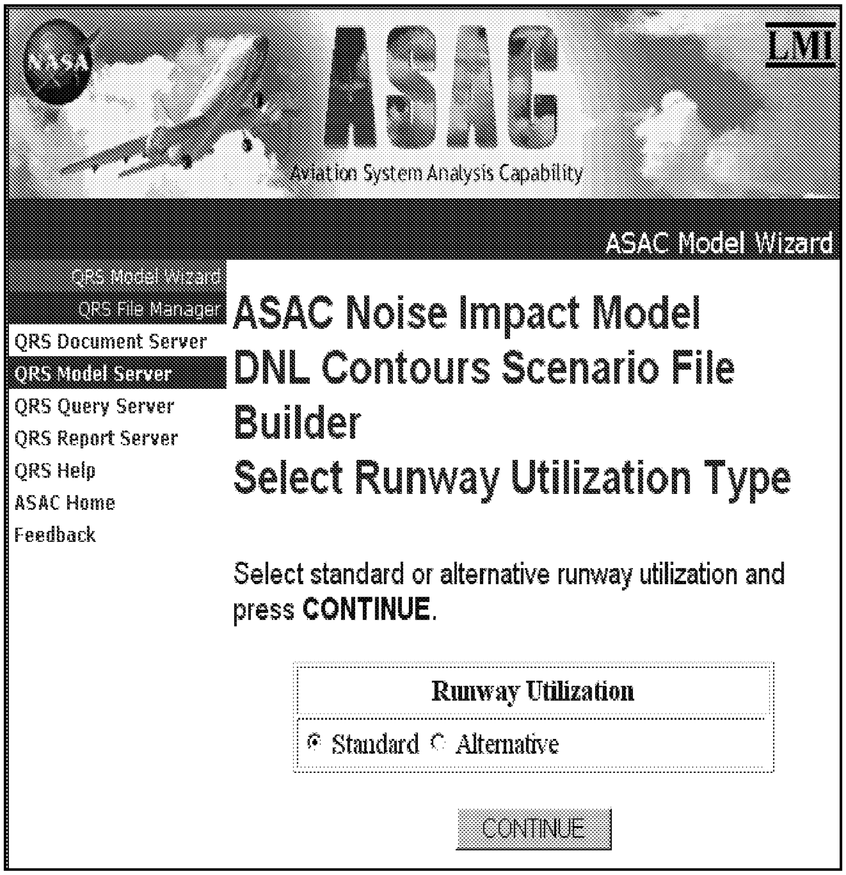


Figure D-8. Global Noise Reduction

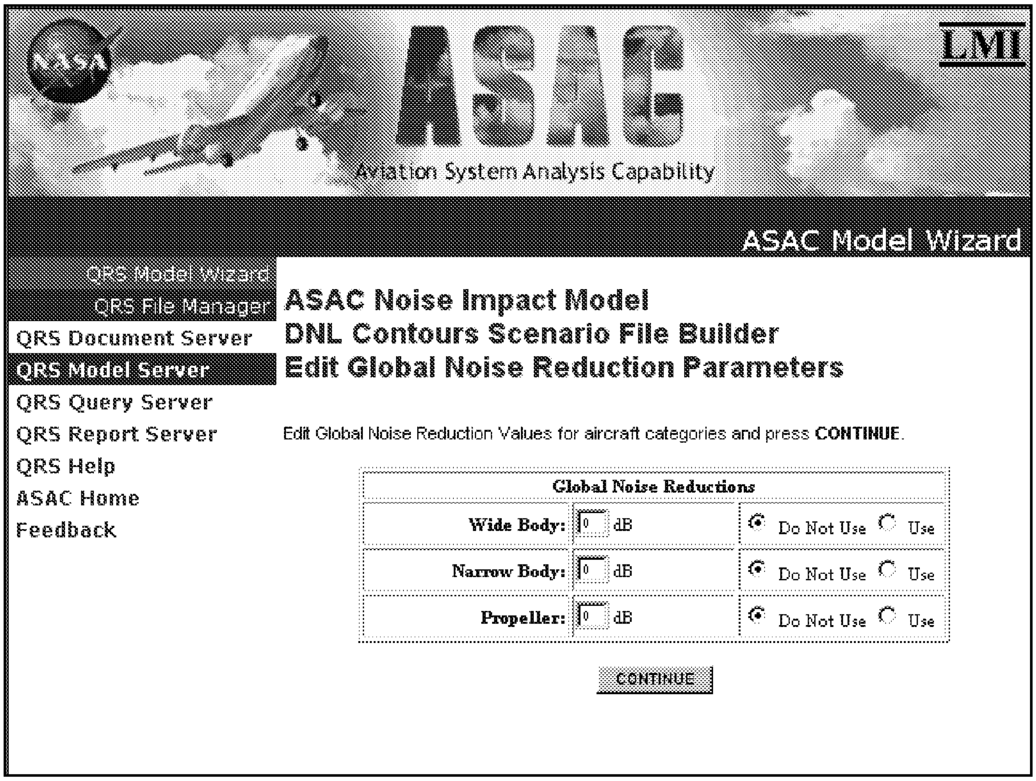


Figure D-9. Aircraft Selection (Part 1)

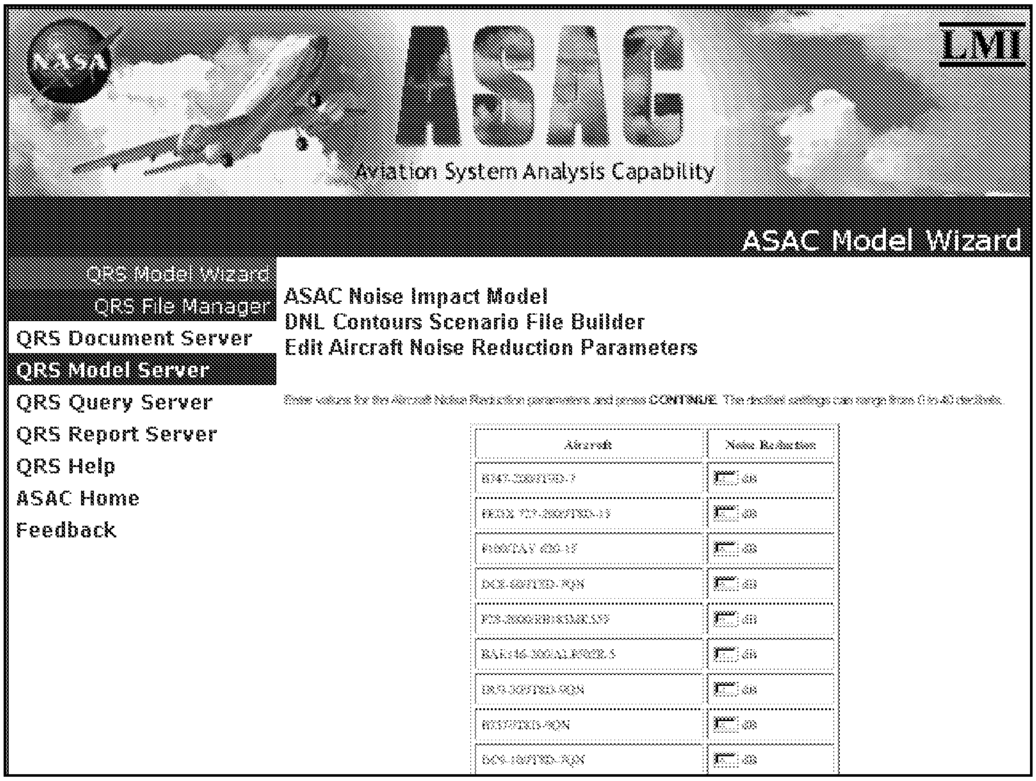


Figure D-10. Aircraft Selection (Part 2)

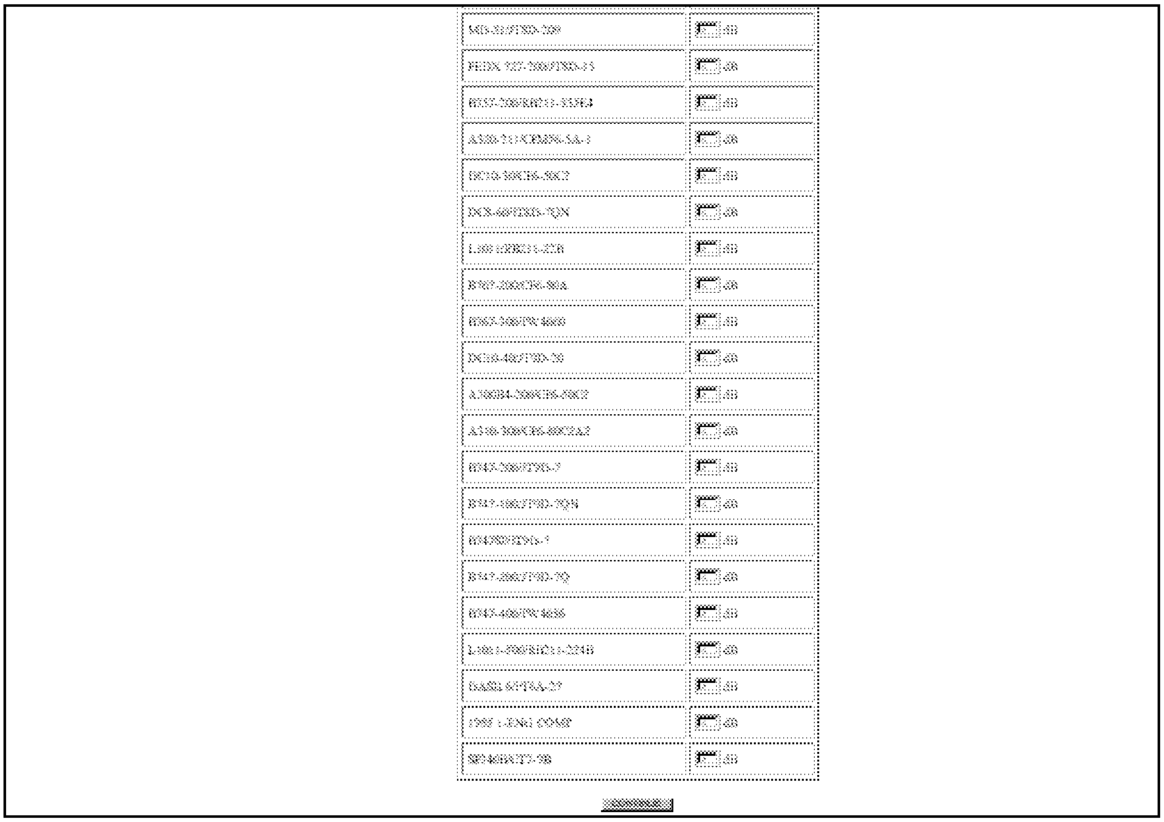


Figure D-11. Select Number of Countour Levels

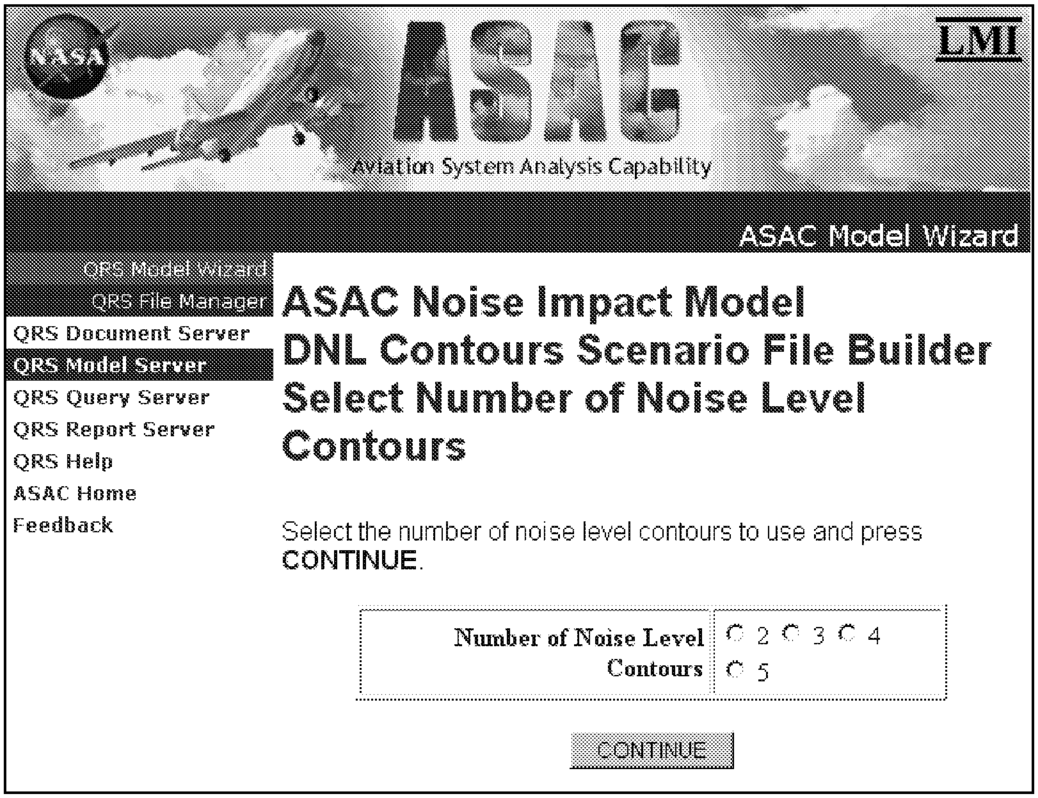


Figure D-12. Set Contour Decibel Levels

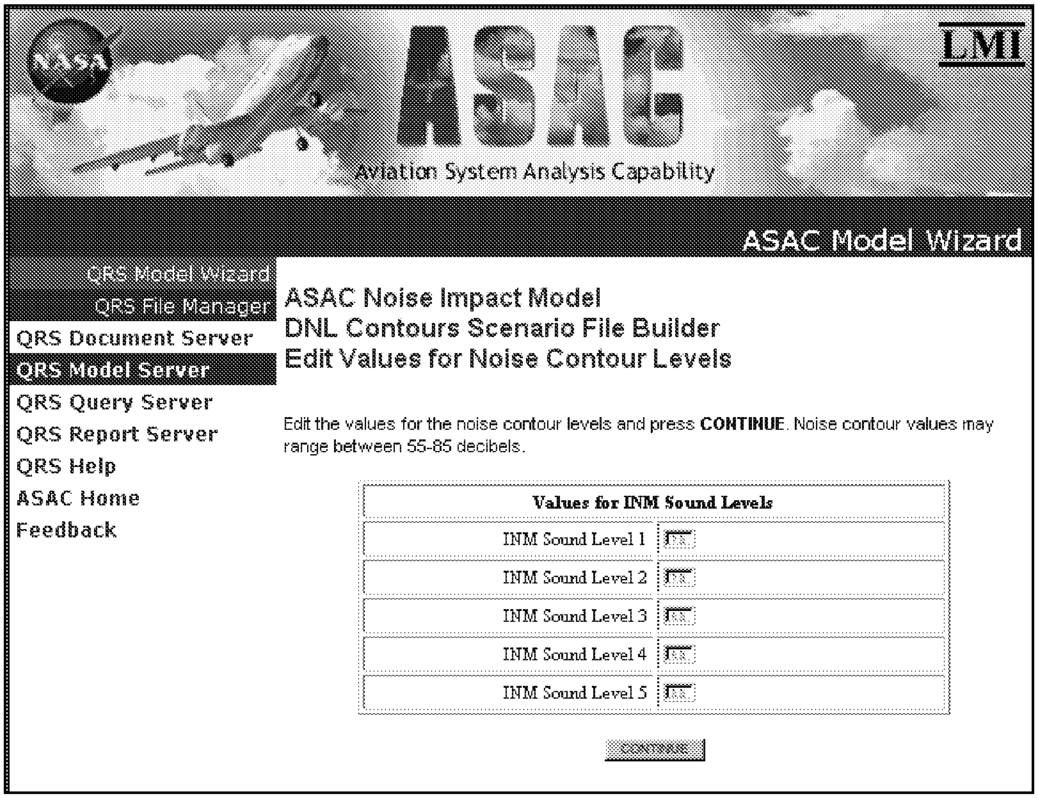


Figure D-13. User Comments

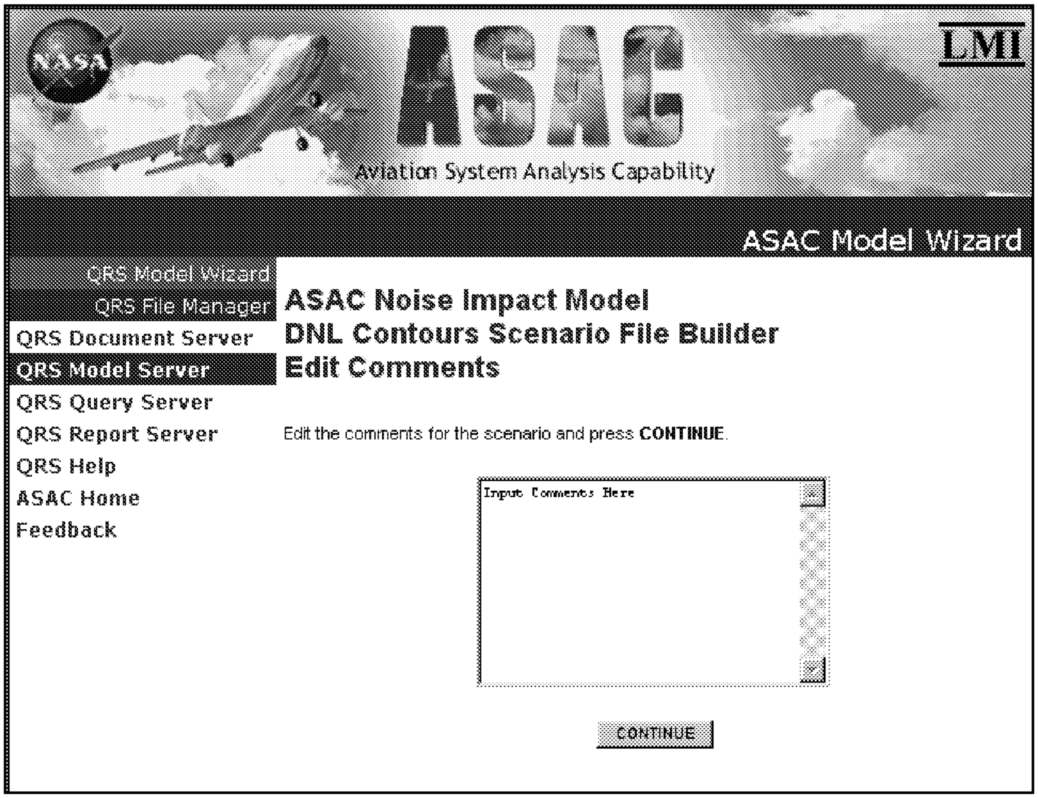


Figure D-14. Save Scenario File

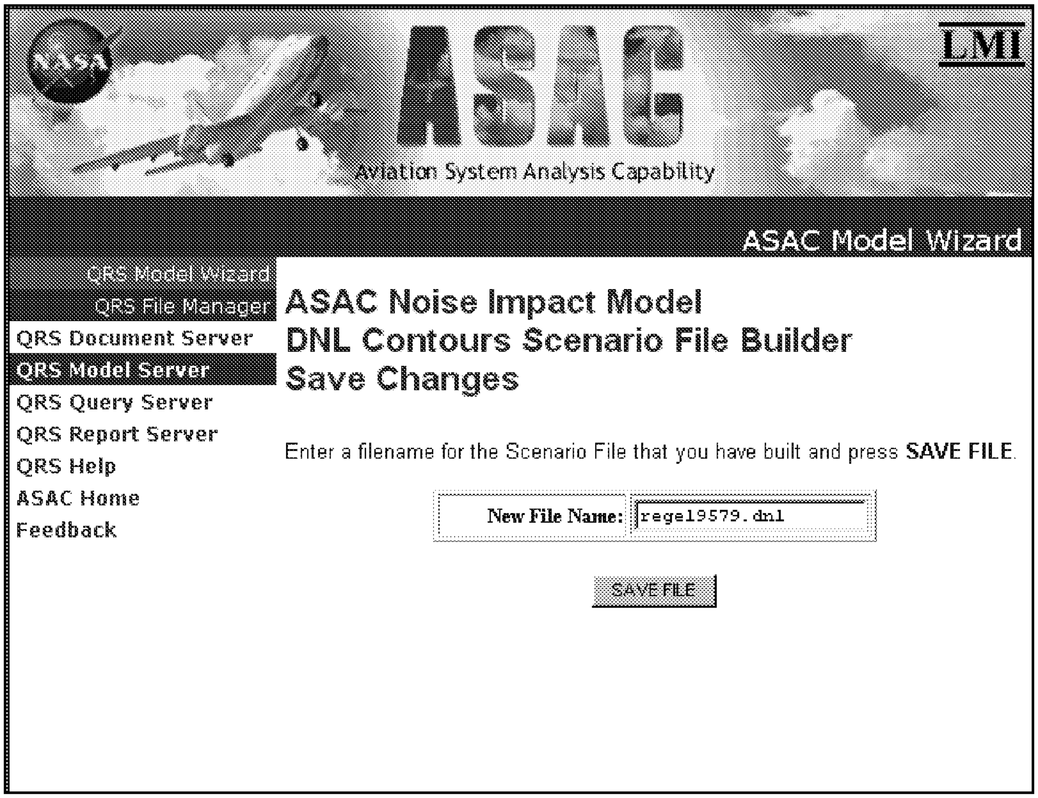
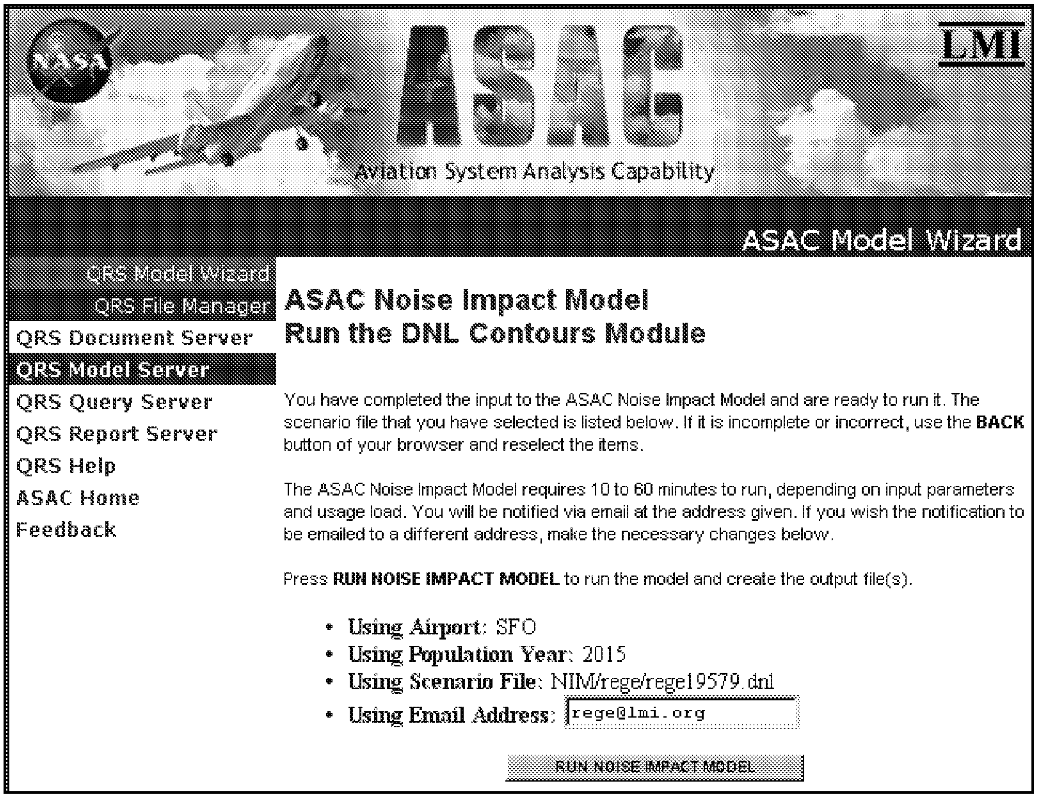


Figure D-15. Run the Noise Impact Model



Appendix E
Abbreviations

ASAC	=	Aviation System Analysis Capability
DNL	=	day-night average sound level
EA	=	economic areas, U.S. census
FTNIM	=	Flight Track Noise Impact Model
GIS	=	Geographic Information System
INM	=	Integrated Noise Model
NIM	=	Noise Impact Model
OAG	=	Official Airline Guides

Appendix F

Existing Aircraft Noise Parameters

Table F-1. Aircraft Noise Parameters

Aircraft	Category	Approach	Noise #
707	JCOM	STD3D	1
707120	JCOM	STD3D	2
707320	JCOM	STD3D	2
707QN	JCOM	STD3D	3
720	JCOM	STD3D	1
720B	JCOM	STD3D	2
727100	JCOM	STD3D	9
72710A	JCOM	STD3D	0
727200	JCOM	STD3D	9
72720A	JCOM	STD3D	0
727D15	JCOM	STD3D	9
727D17	JCOM	STD3D	10
727EM1	JCOM	STD3D	62
727EM2	JCOM	STD3D	63
727Q15	JCOM	STD3D	10
727Q7	JCOM	STD3D	10
727Q9	JCOM	STD3D	10
737	JCOM	STD3D	13
737300	JCOM	STD3D	49
7373B2	JCOM	STD3D	49
737400	JCOM	STD3D	49
737500	JCOM	STD3D	49
737D17	JCOM	STD3D	14
737QN	JCOM	STD3D	14
747100	JCOM	STD3D	6
74710Q	JCOM	STD3D	7
747200	JCOM	STD3D	7
74720A	JCOM	STD3D	50
74720B	JCOM	STD3D	50
747400	JCOM	STD3D	67
747SP	JCOM	STD3D	7
757PW	JCOM	STD3D	53

Table F-1. Aircraft Noise Parameters (Continued)

Aircraft	Category	Approach	Noise #
757RR	JCOM	STD3D	52
767300	JCOM	STD3D	60
767CF6	JCOM	STD3D	60
767JT9	JCOM	STD3D	60
A300	JCOM	STD3D	19
A310	JCOM	STD3D	19
A320	JCOM	STD3D	66
A7D	JMIL	MIL3D	48
BAC111	JCOM	STD3D	13
BAE146	JCOM	STD3D	5
BAE300	JCOM	STD3D	5
BEC58P	PGA	STD3D	42
C130	PMIL	MIL3D	32
C130E	PMIL	MIL3D	31
CIT3	JGA	STD3D	30
CL600	JGA	STD3D	27
CL601	JGA	STD3D	28
CNA441	PCOM	STD3D	39
CNA500	JGA	STD3D	25
COMJET	JGA	STD3D	21
COMSEP	PGA	STD3D	43
CONCRD	JCOM	STD3D	8
CVR580	PCOM	STD3D	34
DC1010	JCOM	STD3D	11
DC1030	JCOM	STD3D	11
DC1040	JCOM	STD3D	11
DC3	PCOM	STD3D	41
DC6	PCOM	STD3D	40
DC820	JCOM	STD3D	1
DC850	JCOM	STD3D	2
DC860	JCOM	STD3D	2
DC870	JCOM	STD3D	4
DC8QN	JCOM	STD3D	3
DC910	JCOM	STD3D	13
DC930	JCOM	STD3D	13
DC950	JCOM	STD3D	14
DC9Q7	JCOM	STD3D	14
DC9Q9	JCOM	STD3D	14

Table F-1. Aircraft Noise Parameters (Continued)

Aircraft	Category	Approach	Noise #
DHC6	PCOM	STD3D	38
DHC7	PCOM	STD3D	58
DHC8	PCOM	STD3D	59
DHC830	JCOM	STD3D	59
F10062	JCOM	STD3D	64
F10065	JCOM	STD3D	65
F16A	JMIL	MIL3D	70
F16GE	JMIL	MIL3D	71
F16PW0	JMIL	MIL3D	72
F16PW9	JMIL	MIL3D	73
F28MK2	JCOM	STD3D	56
F28MK4	JCOM	STD3D	57
F4C	JMIL	MIL3D	47
FAL20	JGA	STD3D	24
GASEPF	PGA	STD3D	45
GASEPV	PGA	STD3D	44
GIIB	JGA	STD3D	29
GIV	JGA	STD3D	64
HS748A	PCOM	STD3D	35
IA1125	JGA	STD3D	30
KC135	JMIL	MIL3D	46
KC135B	JMIL	MIL3D	2
KC135R	JMIL	MIL3D	61
L1011	JCOM	STD3D	12
L10115	JCOM	STD3D	12
L188	PCOM	STD3D	31
LEAR25	JGA	STD3D	22
LEAR35	JGA	STD3D	23
MD11GE	JCOM	STD3D	68
MD11PW	JCOM	STD3D	69
MD81	JCOM	STD3D	54
MD82	JCOM	STD3D	54
MD83	JCOM	STD3D	54
MU3001	JGA	STD3D	26
SABR80	JGA	STD3D	24
SD330	PCOM	STD3D	36
SF340	PCOM	STD3D	37

Appendix G

Aircraft Perceived Decibel Level by Thrust and Distance

Table G-1. Aircraft Decibel Level By Thrust And Distance

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
1	EPNL	4000	113.7	108.2	104.3	100	91.3	79.4	70.5	62.3	53.7	44.7
1	EPNL	6000	115.7	110.2	106.3	102	93.6	81.7	72.8	64.8	56.2	47.2
1	EPNL	10000	121.2	115.8	111.8	107.5	99.3	89.5	82.9	76.4	68.2	59.3
1	EPNL	12000	124.3	118.9	114.8	110.5	102.5	94	88	81.5	73.4	64.8
1	EPNL	15000	130.3	125.1	120.9	116.5	108.8	100.9	95	88.7	81.1	72.2
1	SEL	4000	110.8	105.4	101.2	97	89.6	80.6	74.3	68.6	60.9	52.7
1	SEL	6000	112.7	107.3	103.3	99	91.8	82.9	76.8	71.1	63.6	55.7
1	SEL	10000	117.4	112.4	108.7	104.5	97.4	89.2	83.3	76.9	69.4	61.5
1	SEL	12000	120	115.2	111.6	107.5	100.6	92.6	86.6	80.3	72.6	64.7
1	SEL	15000	125.5	120.8	117.6	113.5	106.9	99.3	93.3	86.6	78.7	70.6
2	EPNL	4000	119.3	114.3	110.4	105.7	96.8	83.9	73.7	64.7	56.5	48.4
2	EPNL	6000	121.8	116.8	112.9	108.2	99.3	87	76.6	69.8	61.3	53.6
2	EPNL	8000	124.4	119.3	115.4	110.7	101.8	90.9	82.8	75.2	67	59.1
2	EPNL	10000	126.6	121.5	117.5	112.8	103.9	94.3	88.2	80.1	72.3	64.2
2	EPNL	12000	127.4	122.3	118.3	113.5	104.5	96.4	91.1	84.4	77.1	69
2	EPNL	15000	128.2	123.4	119.3	114.5	105.6	98.4	92.8	86.6	79.7	71.6
2	SEL	4000	112.5	107.5	103.6	99	90	78.3	71.2	64.5	57	49.5
2	SEL	6000	114.8	109.8	105.9	101.5	92.8	81.8	75.2	68.9	61.7	54.1
2	SEL	8000	117.1	112	108.2	104	95.9	85.9	79.6	73.4	66.1	58.6
2	SEL	10000	119	113.9	110.1	106	98.5	90	83.7	77.5	70.1	62.8
2	SEL	12000	120.7	115.6	111.9	107.7	100.8	92.6	87.1	81	73.9	66.5

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
2	SEL	15000	122.5	117.4	113.6	109.5	103.1	96.4	90.8	85.1	77.9	70.4
3	EPNL	3000	112.1	106.7	102.5	97.6	88.7	78.9	71.8	65.1	57.1	46.8
3	EPNL	5000	113.3	108.1	103.8	98.7	89.5	80.1	73.5	66.9	58.9	48.3
3	EPNL	11000	114.4	110.1	106.9	103.4	97.7	90.6	85.3	79.3	72.7	65.4
3	EPNL	15500	120.8	116.8	114	110.8	105.8	100.2	96.1	91.4	85.2	78.4
3	SEL	3000	104.4	99.4	95.6	91.4	84.8	77.8	72.6	66.7	59.9	52.7
3	SEL	5000	105.1	100	96.2	91.9	85.4	78.4	73.2	67.3	60.6	53.7
3	SEL	11000	109.1	105.4	102.7	99.8	95	88.9	84.2	78.6	72.1	65.2
3	SEL	15500	116.9	113.3	110.8	108.1	103.5	98.1	94.1	89.4	83.9	77.7
4	EPNL	5000	102.9	98	94.2	89.7	82.7	75.3	70.1	64.1	56.8	46.4
4	EPNL	10000	106.3	101.5	97.8	93.6	87	79.9	74.8	68.8	61.6	52.2
4	EPNL	15500	111.1	106.5	102.9	99.1	93.1	86.4	81.3	75.5	68.4	60.4
4	SEL	5000	97.9	93.5	90.4	87.1	81.9	75.6	70.7	64.9	58.2	51
4	SEL	10000	101.5	97.2	94.2	91	85.9	79.8	75	69.3	62.6	55.4
4	SEL	15500	106.5	102.5	99.6	96.5	91.6	85.7	81	75.5	68.9	61.6
5	EPNL	1600	96.9	92.5	89	84.7	77.9	69.5	63.7	56.7	47.6	34.5
5	EPNL	5200	106.1	102.1	98.9	95.2	88.9	81.7	76.6	70.9	64.4	55.2
5	SEL	1600	92.9	89	86	82.7	77.3	70.4	65	58.7	51.6	44.3
5	SEL	5200	102.3	98.4	95.4	92.1	86.8	80.4	75.6	70.3	64.4	58.7
6	EPNL	8000	114	108.9	105.1	101	93.6	84.2	76.3	69.2	61.2	51.2
6	EPNL	14000	120	114.9	111.1	107	99.6	90.2	82.3	75.2	67.2	57.2
6	EPNL	20000	123.8	118.8	114.9	110.5	102.2	92.6	86.4	80	72.7	64.4
6	EPNL	28000	125.4	120.4	116.5	112	103.4	93.8	88.1	81.9	74.8	67.1
6	EPNL	36000	126.9	121.9	118	113.5	104.9	95.3	89.6	83.4	76.3	68.6
6	SEL	8000	108.2	103.5	99.9	96	89.1	80.6	74.2	67.6	60.9	53.7
6	SEL	14000	113.2	108.5	104.9	101	94.1	85.6	79.2	72.6	65.9	58.7
6	SEL	20000	116.6	111.8	108.1	104	96.9	89	83.4	77.3	70.7	63.4

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
6	SEL	28000	118.7	113.9	110.2	106	98.8	91.2	85.9	80	73.5	66.2
6	SEL	36000	120.2	115.4	111.7	107.5	100.3	92.7	87.4	81.5	75	67.7
7	EPNL	8000	106.9	102.2	98.4	93.8	85.4	77.4	71.9	65.7	58.2	49.3
7	EPNL	16000	112.6	107.9	104.1	99.5	91.1	83.1	77.6	71.4	63.9	55
7	EPNL	24000	116.3	111.7	108.1	103.9	96.1	89.2	83.7	77.6	70.9	63.1
7	EPNL	32000	118.6	114	110.5	106.5	99.5	92.5	87.1	81	74.7	67.4
7	EPNL	40000	120.6	116	112.5	108.5	101	94.5	89.1	83	76.7	69.4
7	SEL	8000	102.3	97.8	94.3	90.5	84.4	77.7	72.9	67.3	60.7	53.3
7	SEL	16000	106.3	101.8	98.3	94.5	88.4	81.7	76.9	71.3	64.7	57.3
7	SEL	24000	109.4	105.1	101.7	98	92.2	85.8	81.2	75.9	69.7	62.8
7	SEL	32000	111.8	107.4	104.1	100.5	94.9	88.7	84.2	79.1	73.1	66.5
7	SEL	40000	113.8	109.4	106.1	102.5	96.9	90.7	86.2	81.1	75.1	68.5
8	EPNL	10000	121.1	116.9	113	109.2	102.7	95.6	89.9	86.7	76.4	67.4
8	EPNL	20000	133.9	128.9	124.9	120.8	114.4	106.9	100.9	94.5	87.7	79.5
8	EPNL	28000	140.5	135.3	131.2	126.8	120.3	112.7	106.7	100.3	93.5	85.7
8	EPNL	32000	142.4	137.1	133	128.4	121.8	114.2	108.2	101.8	95.1	87.4
8	SEL	10000	117.7	113.4	110.3	107	101.5	94.8	89.6	83.5	76.5	68.3
8	SEL	20000	130.3	125.5	122	118.3	112.6	106.1	101.1	95.3	88.3	80.3
8	SEL	28000	136.4	131.3	127.6	123.8	118	111.4	106.4	100.6	93.7	85.7
8	SEL	32000	138.4	133.2	129.4	125.5	119.6	113	108	102.2	95.3	87.4
9	EPNL	3000	109	104.4	100.7	96.4	89	80.6	75	68.4	61	51.4
9	EPNL	6000	112.3	107.8	104.1	99.9	93	85	79.3	73	65.3	56.1
9	EPNL	8000	114.9	110.4	106.7	102.9	96	88.2	82.6	76.7	69.6	61.3
9	EPNL	10000	117.7	113.5	110	106.3	100	92.8	87.9	82.3	75.8	68.1
9	EPNL	12000	121.3	117.2	114	110.6	104.8	98.1	93.8	88.5	82.5	75.5
9	EPNL	14000	125.9	121.9	119.1	115	110	103.7	99.3	94.9	89.5	83.1
9	SEL	3000	104.3	99.2	94.9	90.5	84.8	77.6	72.9	67.4	60.8	53.8

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
9	SEL	6000	108.1	102.5	98.7	95	89.2	82.9	78.1	72.7	66.1	58.9
9	SEL	8000	110.8	105.9	102.5	98.8	93.5	87.7	82.5	77.1	70.9	64
9	SEL	10000	113.4	109.2	106.3	103.1	97.7	91.5	87	81.8	75.5	68.7
9	SEL	12000	117.1	113.1	110.4	107.5	102.2	96.3	91.9	87	80.8	74.1
9	SEL	14000	121.8	117.9	115.3	112.5	107.4	101.7	97.3	92.3	86.5	80.4
10	EPNL	3000	100.6	96.4	93.1	89.4	83.4	76.4	71.1	65	57.5	48.8
10	EPNL	6000	106.4	102.2	98.9	95.2	89.2	82.2	76.9	70.8	63.3	54.6
10	EPNL	8000	110.7	106.5	103.3	99.7	93.8	87.1	82	76.3	69.3	61.1
10	EPNL	10000	115.2	111.2	108	104.5	98.8	92.2	87.5	82.1	75.6	68
10	EPNL	12000	119.4	115.8	112.7	109.3	103.7	97.4	93	88	82	75
10	EPNL	14000	124.8	120.9	117.9	114.6	109.2	103.1	99	94.4	89	82.6
10	SEL	3000	96.6	92.8	89.8	86.8	81.8	75.4	71	65.6	59.2	52.2
10	SEL	6000	101.8	98	95.1	92	87	80.9	76.2	70.8	64.4	57.4
10	SEL	8000	106.3	102.6	99.7	96.7	91.7	85.7	81.1	75.8	69.6	62.8
10	SEL	10000	111	107.2	104.5	101.5	96.6	90.6	86.1	81	74.9	68.3
10	SEL	12000	115.8	112.1	109.4	106.5	101.6	95.8	91.3	86.2	80.4	74.1
10	SEL	14000	121.1	117.4	114.8	112	107.1	101.4	97	92.1	86.4	80.4
11	EPNL	8000	105.5	100.1	95.8	91	82.1	73.7	67.7	61	52.2	43.3
11	EPNL	14000	110	105	100.9	96.5	88.5	80.6	75	68.7	60.9	52.6
11	EPNL	20000	112.1	107.2	103.3	99	91.5	83.8	78.4	72.3	64.8	56.8
11	EPNL	28000	114.1	109.4	105.6	101.5	94.4	87	81.7	75.8	68.8	61.1
11	EPNL	36000	116.2	111.6	107.9	104	97.3	90.1	85	79.3	72.7	65.3
11	SEL	8000	100.7	95.5	91.7	87.5	81.1	74	68.8	63	56.3	49.7
11	SEL	14000	104.4	99.5	95.9	92	85.9	79	73.9	68.3	61.7	55.2
11	SEL	20000	106.2	102.2	98.7	95	89	82.3	77.3	71.8	65.4	58.9
11	SEL	28000	109.3	104.8	101.4	98	92.2	85.6	80.7	75.3	69	62.6
11	SEL	36000	110.9	106.6	103.3	100	94.3	87.8	83	77.6	71.4	65.1

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
12	EPNL	8000	104	98.6	94.3	89.5	80.6	72.2	66.2	59.5	50.7	41.8
12	EPNL	14000	108.6	103.5	99.4	95	87	79.1	73.5	67.2	59.3	51
12	EPNL	20000	110.6	105.7	101.8	97.5	90	82.2	76.8	70.7	63.2	55.1
12	EPNL	28000	113	108.2	104.4	100.3	93.2	85.7	80.4	74.5	67.5	59.8
12	EPNL	36000	115.2	110.6	106.9	103	96.3	89.1	84	78.3	71.7	64.3
12	SEL	8000	100.7	95.5	91.7	87.5	81.1	74	68.8	63	56.3	49.7
12	SEL	14000	104.8	100	96.4	92.5	86.4	79.5	74.5	68.8	62.3	55.8
12	SEL	20000	107.3	102.6	99.1	95.5	89.5	82.8	77.8	72.3	65.8	59.5
12	SEL	28000	109.8	105.3	101.9	98.5	92.7	86.1	81.2	75.8	69.5	63.2
12	SEL	36000	111.4	107.1	103.8	100.5	94.8	88.3	83.5	78.1	71.9	65.6
13	EPNL	3000	107	102.4	98.7	94.4	87	78.6	73	66.4	59	49.4
13	EPNL	6000	110.3	105.8	102.1	97.9	91	83	77.3	71	63.3	54.1
13	EPNL	8000	112.9	108.4	104.7	100.9	94	86.2	80.6	74.7	67.6	59.3
13	EPNL	10000	115.7	111.5	108	104.3	98	90.8	85.9	80.3	73.8	66.1
13	EPNL	12000	119.3	115.2	112	108.6	102.8	96.1	91.8	86.5	80.5	73.5
13	EPNL	14000	123.9	119.9	117.1	113	108	101.7	97.3	92.9	87.5	81.1
13	SEL	3000	102.3	97.2	92.9	88.5	82.8	75.6	70.9	65.4	58.8	51.8
13	SEL	6000	106.1	100.5	96.7	93	87.2	80.9	76.1	70.7	64.1	56.9
13	SEL	8000	108.8	103.9	100.5	96.8	91.5	85.7	80.5	75.1	68.9	62
13	SEL	10000	111.4	107.2	104.3	101.1	95.7	89.5	85	79.8	73.5	66.7
13	SEL	12000	115.1	111.1	108.4	105.5	100.2	94.3	89.9	85	78.8	72.1
13	SEL	14000	119.8	115.9	113.3	110.5	105.4	99.7	95.3	90.3	84.5	78.4
14	EPNL	3000	98.6	94.4	91.1	87.4	81.4	74.4	69.1	63	55.5	46.8
14	EPNL	6000	104.4	100.2	96.9	93.2	87.2	80.2	74.9	68.8	61.3	52.6
14	EPNL	8000	108.7	104.5	101.3	97.7	91.8	85.1	80	74.3	67.3	59.1
14	EPNL	10000	113.2	109.2	106	102.5	96.6	90.2	85.5	80.1	73.6	66
14	EPNL	12000	117.8	113.8	110.7	107.3	101.7	95.4	91	86	80	73

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
14	EPNL	14000	122.8	118.9	115.9	112.6	107.2	101.1	97	92.4	87	80.6
14	SEL	3000	94.6	90.8	87.9	84.8	79.8	73.4	69	63.6	57.2	50.2
14	SEL	6000	99.8	96	93.1	90	85	78.9	74.2	68.8	62.4	55.4
14	SEL	8000	104.3	100.6	97.7	94.7	89.7	83.7	79.1	73.8	67.6	60.8
14	SEL	10000	109	105.2	102.5	99.5	94.6	88.6	84.1	79	72.9	66.3
14	SEL	12000	113.8	110.1	107.4	104.5	99.6	93.8	89.3	84.2	78.4	72.1
14	SEL	14000	119.1	115.4	112.8	110	105.1	99.4	95	90.1	84.4	78.4
15	EPNL	2000	102.4	97.5	93.8	89.8	83.6	76.4	70.9	64.4	56.7	45.8
15	EPNL	4000	107.4	102.5	98.8	94.8	88.6	81.4	75.9	69.4	61.7	50.8
15	EPNL	6000	111.4	107	103.8	100.4	94.9	88.7	84	78.5	71.5	62.6
15	EPNL	8000	116.6	112	108.7	105.2	99.5	92.9	88.1	82.5	75.4	66.5
15	EPNL	10000	121.8	117	113.4	109.5	103.4	96.6	91.6	85.8	78.8	69.9
15	SEL	2000	99.2	94.8	91.7	88.3	82.6	76	70.8	64.9	58.1	50.5
15	SEL	4000	103.2	98.8	95.7	92.3	86.6	80	74.8	68.9	62.1	54.5
15	SEL	6000	110.4	106.2	103.2	100	94.7	88.6	84	78.8	72.8	65.8
15	SEL	8000	115.5	111.2	108.1	104.8	99.2	92.6	87.6	81.9	75.5	67.8
15	SEL	10000	120.5	116.1	113	109.5	103.7	96.6	91.1	84.9	77.9	69.8
16	EPNL	4000	95.5	90.8	87.5	84	78.3	71.6	66.5	59.9	52.7	41.4
16	EPNL	8000	102.1	97.4	94.1	90.6	84.9	78.6	73.1	66.5	59.3	48
16	EPNL	12000	105.4	101.5	98.7	95.5	90.2	83.7	78.6	72.8	65.4	57.2
16	EPNL	16000	109.9	106	103.5	100	94.7	88.2	83.1	77.3	69.9	61.7
16	SEL	4000	91	87	84.4	81.5	76.9	71.1	66.4	60.9	54.2	46.7
16	SEL	8000	97.5	93.5	90.9	88	83.4	77.6	72.9	67.4	60.7	53.2
16	SEL	12000	102.2	98.7	96.1	93.3	88.5	82.5	77.7	72.1	65.6	58.4
16	SEL	16000	106.9	103.4	100.8	98	93.2	87.2	82.4	76.8	70.3	63.1
17	EPNL	4000	101	96.7	93.4	89.6	83.3	75.7	69.8	62.9	54.1	41.8
17	EPNL	10000	103.8	99.5	96.3	92.5	86.2	78.7	73.1	66.6	58.2	48

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
17	EPNL	16000	107.6	103.3	100.1	96.4	90.2	82.8	77.5	71.6	64.7	56.3
17	SEL	4000	96.6	92.8	90.1	87	81.9	75.5	70.4	64.2	56.8	48.9
17	SEL	10000	99.5	95.7	92.9	89.9	84.7	78.4	73.6	67.5	60	52.6
17	SEL	16000	103.7	99.8	96.9	93.8	88.7	82.6	77.8	72	65.1	57.9
18	EPNL	5000	103.7	98.6	94.7	90	81.7	72.5	65.5	58.9	50.9	40.8
18	EPNL	10000	105.7	100.6	96.7	92	83.7	74.5	67.5	60.9	52.9	42.8
18	EPNL	20000	109.1	104.4	100.8	96.7	89.8	81.7	75.8	69.8	62.5	54
18	EPNL	30000	112.9	108.5	105.1	101.4	95.5	88.1	83	77.4	70.7	63.2
18	SEL	5000	97.4	92.5	88.9	85	78.8	72.1	67.2	61.7	55.2	48.2
18	SEL	10000	99.4	94.5	90.9	87	80.8	74.1	69.2	63.7	57.2	50.2
18	SEL	20000	102.8	98.5	95.4	92	86.4	80	75.2	69.9	63.7	57
18	SEL	30000	106.7	102.8	100	97	91.9	85.6	80.9	75.8	69.8	63.3
19	EPNL	10000	106.2	101.1	97.2	92.5	84.2	75	68	61.4	53.4	43.3
19	EPNL	25000	109.8	105.1	101.5	97.3	90.3	82	76	70	62.7	53.9
19	EPNL	40000	113	108.6	105.2	101.5	95.6	88.2	83.1	77.5	70.8	63.3
19	SEL	10000	99.9	95	91.4	87.5	81.3	74.6	69.7	64.2	57.7	50.7
19	SEL	25000	103.7	99.3	96.1	92.7	87.1	80.6	75.8	70.5	64.3	57.5
19	SEL	40000	106.8	102.9	100.1	97.1	92	85.8	81	75.9	69.9	63.4
20	EPNL	10000	106.7	101.6	97.7	93	84.7	75.5	68.5	61.9	53.9	43.8
20	EPNL	25000	109.8	105.1	101.5	97.3	90.3	82	76	70	62.7	53.9
20	EPNL	38000	112.6	108.2	104.8	101.1	95.2	87.8	82.7	77.1	70.4	62.9
20	SEL	10000	100.4	95.5	91.9	88	81.8	75.1	70.2	64.7	58.2	51.2
20	SEL	25000	103.6	99.2	96	92.6	87	80.5	75.7	70.4	64.2	57.4
20	SEL	38000	106.4	102.5	99.7	96.7	91.6	85.3	80.6	75.5	69.5	63
21	EPNL	30	99.2	94.3	90.5	86.4	79.2	71	65	57.9	50	39.7
21	EPNL	60	111.4	107	103.2	99	91.9	84.1	78.1	71.1	62.9	53.2
21	EPNL	100	122	116.3	112.1	107.1	98.6	90.3	84.1	76.9	68.3	58.4

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
21	SEL	30	95.8	91.8	88.6	85.1	79.2	72.3	67	60.9	54.2	46.9
21	SEL	60	109.5	105	101.8	98.3	92.2	84.9	79.2	72.3	64.5	55.6
21	SEL	100	119	114	110.3	106.3	99.6	91.8	85.6	78.5	70.1	60.6
22	EPNL	700	102.9	98.1	94.5	90.6	83.7	75.5	69.5	62.5	54.6	44.6
22	EPNL	1800	121.7	116.7	112.9	108.7	101.6	93.8	87.9	80.9	72.6	63
22	EPNL	2600	127.6	121.9	117.7	112.8	104.2	96	89.9	82.6	74	64.2
22	SEL	700	100.8	96.4	93.3	89.9	84	77	71.5	65.1	57.8	49.6
22	SEL	1800	119.3	114.8	111.6	108	101.9	94.5	88.6	81.6	73.4	63.9
22	SEL	2600	124.7	119.7	116	112	105.3	97.5	91.3	84.1	75.7	66.1
23	EPNL	1000	98.1	92.9	88.9	84.4	76.5	68.3	62.1	55	47	36.2
23	EPNL	1500	103.6	98.5	94.8	90.5	82.9	75.1	69.3	62.6	54.7	44.9
23	EPNL	2650	114.8	108.9	104.3	99	90.9	82.3	75.5	67.6	59.4	47.8
23	SEL	1000	93.7	89	85.6	81.8	75.6	68.9	64.1	58.8	53.1	46.9
23	SEL	1500	99.3	94.8	91.4	87.8	81.8	74.9	69.7	64	57.6	50.6
23	SEL	2650	110.5	105	101.1	97.1	90.6	83	77.1	70.3	62.5	53.8
24	EPNL	850	106.9	101.5	97.2	92	81.9	72.4	66.5	60	52.6	41.8
24	EPNL	1500	109	103.7	99.8	95.5	87	77.4	70.8	63.6	55.2	46.1
24	EPNL	2500	109.5	104.2	100.3	96	88.8	81.4	76	69.9	62.9	53.7
24	EPNL	3750	115.3	109.9	105.8	101	92.9	85	79.2	72.6	64.8	54.1
24	SEL	850	100.7	95.3	91.2	86.4	78.7	71.4	66.2	60.5	54.4	47.4
24	SEL	1500	102.8	97.8	94.1	90	83.4	75.9	70.1	63.7	57.2	50
24	SEL	2500	104.2	99.5	96.1	92.5	86.7	79.9	74.7	68.9	62.3	55.1
24	SEL	3750	111.3	106.4	102.8	99	92.6	85.1	79.2	72.7	65.4	57.4
25	EPNL	300	89.8	84.7	80.7	76.3	69.8	62.2	55.9	48.2	38.4	19.5
25	EPNL	600	91	85.9	81.9	77.5	71	63.4	57.1	49.4	39.6	20.7
25	EPNL	1200	101.4	96.3	92.4	87.7	79.9	72.1	66.3	59.8	51.7	40.4
25	EPNL	1550	102.4	97.4	93.6	89.5	83	75.4	69.4	62.3	54.2	43.2

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
25	SEL	300	85.6	81	77.7	74.2	68.5	62.3	57.6	52.3	46.2	39.2
25	SEL	600	86.8	82.2	78.9	75.4	69.7	63.5	58.8	53.5	47.4	40.4
25	SEL	1200	96.4	91.7	88.2	84.5	78.3	71.4	66.3	60.6	54.2	47.1
25	SEL	1550	98	93.6	90.4	87	81.4	74.8	69.7	63.9	57.1	49.5
26	EPNL	670	95.4	90.4	86.6	82	74	65.7	59.6	52.4	43.8	31.5
26	EPNL	1500	107.9	102.7	99.2	95.2	88.5	80.7	76.1	70.4	63.3	54.5
26	EPNL	2100	108.6	105	101.7	98.4	92.8	86.2	81.4	75.7	68.6	59.7
26	SEL	670	90.2	85.6	82.2	78.4	72.3	65.3	60.3	54.7	48.4	41.4
26	SEL	1500	104.1	99.8	96.8	93.4	87.3	81.1	76.6	71.3	64.8	57.4
26	SEL	2100	106	102.4	99.7	96.8	91.6	85.7	81.2	75.9	69.3	61.8
27	EPNL	1900	93.8	88.8	85	80.5	72.5	63.3	57.1	49.5	40.5	26.7
27	EPNL	5000	103.8	99.3	96	92.3	85.5	78.8	73.6	67.4	60.4	51.5
27	SEL	1900	90.2	85.5	82.1	78.3	72	64.7	59.4	53.6	47.4	40.7
27	SEL	5000	101.1	96.8	93.8	90.5	85	78.6	73.8	68.4	62.5	55.6
28	EPNL	2000	94.1	89.4	85.9	82	74.9	66.9	60.9	53.5	44.5	30.6
28	EPNL	3000	98.1	93.2	89.4	85.3	79	69.4	63.5	56.3	47.4	34.2
28	EPNL	4000	100.8	95.7	92	87.8	80.7	73.4	67.8	61.4	53.3	42
28	EPNL	5000	102.1	97.2	93.4	89.1	82.4	75.2	69.7	63.3	56.2	46.1
28	EPNL	6000	104	99.1	95.3	91	84.3	77.1	71.6	65.2	58.1	48
28	SEL	2000	90.9	86.7	83.3	79.9	74.1	67.4	62.4	56.9	50.7	43.9
28	SEL	3000	94.3	89.8	86.5	82.9	76.9	70	64.8	59.2	52.9	46
28	SEL	4000	96.3	91.8	88.5	85	79.1	72.5	67.5	61.9	55.6	48.6
28	SEL	5000	97.7	93.2	90	86.5	80.8	74.3	69.5	64.1	57.9	50.7
28	SEL	6000	99.7	95.2	92	88.5	82.8	76.3	71.5	66.1	59.9	52.7
29	EPNL	2000	101.6	96.7	93	89	82.8	75.6	70.1	63.6	55.9	45
29	EPNL	4000	106.6	101.7	98	94	87.8	80.6	75.1	68.6	60.9	50
29	EPNL	6000	113.4	109	105.8	102.4	96.9	90.7	86	80.5	73.5	64.6

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
29	EPNL	8000	120.6	116	112.7	109.2	103.5	96.9	92.1	86.5	79.4	70.5
29	EPNL	10000	126	121.2	117.6	113.7	107.6	100.8	95.8	90	83	74.1
29	SEL	2000	98.4	94	90.9	87.5	81.8	75.2	70	64.1	57.3	49.7
29	SEL	4000	102.4	98	94.9	91.5	85.8	79.2	74	68.1	61.3	53.7
29	SEL	6000	112.5	108.3	105.3	102.1	96.8	90.7	86.1	80.9	74.9	67.9
29	SEL	8000	119.5	115.2	112.1	108.8	103.2	96.6	91.6	85.9	79.5	71.8
29	SEL	10000	124.7	120.3	117.2	113.7	107.9	100.8	95.3	89.1	82.1	74
30	EPNL	880	94.2	89.3	85.5	80.9	73.4	65.6	59.6	52.4	42.6	28.9
30	EPNL	2300	100.2	95.8	92.6	89.1	83.2	76.1	70.9	64.4	57.2	47.8
30	EPNL	3000	107.8	103.4	100.1	96.5	90.4	83.2	77.4	71.9	64.7	55.2
30	SEL	880	87.1	82.9	79.8	76.4	70.8	64.3	59.3	53.8	47.6	41
30	SEL	2300	95.9	92	89.3	86.3	81.3	75.4	70.8	65.1	58.1	50.2
30	SEL	3000	103.4	99.4	96.4	93.8	88.8	82.9	78.3	72.7	65.9	58.3
31	EPNL	30	102.1	97.5	94.1	90.3	83.8	75.9	70	63.7	56.3	45.7
31	EPNL	100	107.2	102.9	99.8	96.6	91.4	85.7	81.4	76.6	71.2	65
31	SEL	30	98	93.7	90.6	87.2	81.4	74.2	68.3	61.8	55.5	49.4
31	SEL	100	100.1	95.8	92.9	89.8	85	80	76.6	72.9	69	64.4
32	EPNL	28	102.9	98	94.4	90.3	83.9	76.6	71	64.7	58	49.1
32	EPNL	100	112.7	108.1	104.7	101.3	95.6	89	83.3	77.1	71.2	64.3
32	SEL	28	98.7	94.2	91.1	87.7	82.1	75.7	70.8	65.5	59.7	53.4
32	SEL	100	106.8	102.6	99.5	96.3	90.8	84.7	80	74.9	69.6	63.9
33	EPNL	30	99	94.1	90.4	86.1	78.6	70.1	64.2	57.3	49	37.2
33	EPNL	100	99.8	95.5	92.2	88.8	83	76.7	71.6	66	59.6	50
33	SEL	30	95.4	90.7	87.4	83.7	77.4	70.2	65	59.6	54.3	48.9
33	SEL	100	93.6	89.4	86.5	83.4	78.4	73	69.2	65	60.6	55.6
34	EPNL	30	99.1	94.5	91.1	87.3	80.8	72.9	67	60.7	53.3	42.7
34	EPNL	100	104.2	99.9	96.8	93.6	88.4	82.7	78.4	73.6	68.2	62

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
34	SEL	30	95	90.7	87.6	84.2	78.4	71.2	65.3	58.8	52.5	46.4
34	SEL	100	97.1	92.8	89.9	86.8	82	77	73.6	69.9	66	61.4
35	EPNL	32	106.5	101.2	96.8	91.5	81.1	69.6	61.9	53.8	45.7	34.2
35	EPNL	73	107.3	102.2	98.1	94.5	88.5	81.3	75.5	69.2	62.9	54.6
35	EPNL	100	107.7	103.3	100.2	96.8	91.2	84.7	79.9	74.2	67.8	59.2
35	SEL	32	98.9	93.5	89.1	84	75.3	67.3	62	56.5	50.8	44.6
35	SEL	73	100.2	95.4	92	88.4	83.1	77.7	73.8	69.5	64.5	58.5
35	SEL	100	101.3	97.2	94.3	91.4	86.7	81.4	77.5	72.8	67.3	60.6
36	EPNL	35	94.4	90.1	87.1	83.9	78.3	71.6	66.1	60.1	54.1	46.2
36	EPNL	65	93.9	89.7	86.7	83.5	78	71.2	64.6	59.6	53.7	46.3
36	EPNL	100	101.2	97	94.1	91	85.9	79.6	73.9	67.7	61.8	54.7
36	SEL	35	88	84	81.3	78.5	74	69.2	65.6	61.6	57	51.6
36	SEL	65	88.5	84.4	81.5	78.5	73.7	68.5	64.8	60.9	56.8	52
36	SEL	100	95.1	91.1	88.4	85.5	81	76.1	72.4	68.4	63.8	58.4
37	EPNL	30	94	89.6	86.5	82.9	77.2	70.6	65.6	59.9	52.9	41
37	EPNL	75	94.8	90.6	87.6	84.3	78.7	72.5	67.9	62.5	56.2	45.6
37	EPNL	100	102.8	98.4	95.3	92	86.4	80.1	75.4	70	63.5	53.4
37	SEL	30	87.5	83.4	80.5	77.5	72.7	67.4	63.6	59.1	53.6	47.3
37	SEL	75	89	85.1	82.5	79.5	75.1	69.9	66.2	62	57.2	51.8
37	SEL	100	97	92.8	90.1	87.3	82.9	77.8	74	69.5	64.1	57.8
38	EPNL	30	94.4	90	86.9	83.5	78	71.6	66.8	61	54	44.9
38	EPNL	100	99.2	95	92.1	89.1	84.3	78.8	74.4	69.3	63.2	55.4
38	SEL	30	91.3	87.2	84.4	81.6	76.9	71.7	67.6	62.9	57.2	50
38	SEL	100	95.9	92	89.3	86.5	82	77	73.1	68.6	63.5	57.4
39	EPNL	30	87.4	83	79.9	76.5	71	64.6	59.8	54	47	37
39	EPNL	100	92.2	88.1	85.3	82.3	77.5	71.5	67	62.1	56.4	49.1
39	SEL	30	84.3	80.2	77.4	74.6	69.9	64.7	60.6	55.9	50.2	43.7

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
39	SEL	100	88.5	84.6	82	79.3	75	70.3	66.7	62.7	57.9	52.2
40	EPNL	30	102.6	98.2	95.1	91.8	86.2	79.4	74	68	61.6	53.2
40	EPNL	100	115.9	111.3	108.2	104.5	98.8	91.9	86.3	80.2	74.1	67
40	SEL	30	99.9	95.7	92.7	89.5	84.3	78.3	74	69.6	64.9	59.6
40	SEL	100	110.5	106	102.9	99.6	94.3	88.4	84	79.2	73.7	67.5
41	EPNL	30	99.6	95.2	92.1	88.8	83.2	76.4	71	65	58.6	50.2
41	EPNL	100	112.9	108.3	105.2	101.5	95.8	88.9	83.3	77.2	71.1	64
41	SEL	30	96.9	92.7	89.7	86.5	81.3	75.3	71	66.6	61.9	56.6
41	SEL	100	107.5	103	99.9	96.6	91.3	85.4	81	76.2	70.7	64.5
42	EPNL	30	90.3	86	83	79.8	74.1	67.8	63.2	57.3	51.9	43.4
42	EPNL	100	102.4	98.2	95.2	92	86.4	80.1	75.4	70.2	64.1	55.9
42	SEL	30	84.6	80.6	77.9	75.1	70.5	65.3	61.4	57.1	52.2	46.8
42	SEL	100	97.6	93.6	90.9	88	83.4	78.3	74.4	70.1	65.3	59.9
43	EPNL	30	83.8	78.5	74.7	70.8	64.3	56.5	49.4	41.7	30.4	18.8
43	EPNL	100	94.2	90	87	83.8	78.2	71.9	67.2	62	55.9	47.7
43	SEL	30	77	72.9	70.1	67.2	62.6	57.6	54	50.2	46	41.4
43	SEL	100	89.9	85.9	83.2	80.3	75.7	70.6	66.7	62.4	57.6	52.2
44	EPNL	30	88	82.7	78.9	75	68.5	60.7	53.6	45.9	34.6	23
44	EPNL	100	98.9	94.7	91.7	88.5	82.9	76.6	71.9	66.7	60.6	52.4
44	SEL	30	81.7	77.6	74.8	71.9	67.3	62.3	58.7	54.9	50.7	46.1
44	SEL	100	94.6	90.6	87.9	85	80.4	75.3	71.4	67.1	62.3	56.9
45	EPNL	30	81.5	76.2	72.4	68.5	62	54.2	47.1	39.4	28.1	16.5
45	EPNL	100	91.4	87.2	84.2	81	75.4	69.1	64.4	59.2	53.1	44.9
45	SEL	30	74.2	70.1	67.3	64.4	59.8	54.8	51.2	47.4	43.2	38.6
45	SEL	100	87.1	83.1	80.4	77.5	72.9	67.8	63.9	59.6	54.8	49.4
46	EPNL	4200	122.7	117.5	113.6	109.4	102	94.1	87.9	81.1	73.9	65.1
46	EPNL	9800	134.8	129.2	125.2	120.7	113.8	106.1	100.3	93.7	86.7	79

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
46	EPNL	15000	136.1	130	125.6	121	114	106.2	100.5	94.1	87.2	78.4
46	SEL	4200	117	112.1	108.6	104.9	98.9	92	86.7	80.8	74.1	66.4
46	SEL	9800	130.9	125.6	122	118.2	112.1	105.1	99.9	93.9	87.1	79.3
46	SEL	15000	132	126.3	122.6	118.8	112.6	105.4	100	93.7	86.6	78.5
47	EPNL	4800	121.8	116.7	112.9	108.7	101.5	93.1	87.1	80.6	73.6	65.3
47	EPNL	9400	137.1	130.6	126.4	121.5	113	103.7	97	89.6	81.2	72.4
47	EPNL	14500	142.2	135	129.8	125	116.9	108.7	102.8	96.5	90.2	83.1
47	SEL	4800	117.9	113.1	109.7	106	99.9	92.9	87.5	81.5	74.7	67
47	SEL	9400	133.6	127.2	122.8	118.4	111.7	104.3	98.4	91.6	83.5	74.2
47	SEL	14500	138.2	131	126	121.4	115	108.1	102.9	97.1	90.5	83.1
48	EPNL	3000	112.2	106.8	102.8	98.6	91	82.6	76.6	69.9	62.5	53.9
48	EPNL	12500	131.3	125.4	120.7	115.8	108.2	99.1	91.6	82.8	72.3	59.6
48	SEL	3000	107.1	102.2	98.7	94.9	88.8	82	76.9	71.2	64.6	57
48	SEL	12500	127.6	121.9	118	114	107.5	99.7	93.5	85.7	75.6	62.4
49	EPNL	3690	100.9	96.1	92.5	88.3	80.9	72.8	66.6	59.5	51.5	43.1
49	EPNL	6180	104.5	99.9	96.5	92.4	85.3	77.4	71.3	64.2	56.3	48
49	EPNL	9880	103.9	99.3	95.8	91.6	84.9	77.7	71.8	65.2	57.5	49.4
49	EPNL	13190	103.2	99	95.9	92.4	86.9	80.2	74.9	68.7	61.6	54.2
49	EPNL	17273	104.5	100.7	98	95.2	90.5	84.2	79.2	73.5	66.9	60
49	EPNL	21180	111.9	108.2	105.4	102.3	96.9	90.4	85.4	79.6	73.1	66.2
49	SEL	3690	96.2	91.7	88.5	85	79.6	73	67.9	61.9	55	47.8
49	SEL	6180	98.3	93.9	90.6	87.3	82	75.7	70.8	65	58.2	51
49	SEL	9880	97.6	93.6	90.7	87.6	82.7	76.8	72.1	66.5	60	53
49	SEL	13190	99.8	95.9	93.1	90.2	85.4	79.6	75	69.5	63.1	56.3
49	SEL	17273	102.8	99.1	96.5	93.7	89.1	83.4	78.9	73.7	67.4	60.7
49	SEL	21180	106.6	103.3	100.9	98.4	94	88.5	84.1	78.9	72.7	66.2
50	EPNL	8560	106.3	102.9	99.8	96.2	89.8	83.9	78.9	70.6	61.6	51

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
50	EPNL	14000	110.2	106.7	103.5	99.7	92.9	86	81.2	73.1	64.8	55.4
50	EPNL	24370	111.1	108	105	101.6	95	87.9	82.1	75.5	67.9	59.8
50	EPNL	34850	115.8	112.8	109.9	106.5	100	92.4	86.4	80.2	72.9	65.4
50	EPNL	40240	119.1	116.1	113.1	109.6	102.8	95.3	90.1	83.9	77.1	70.2
50	EPNL	44940	121.7	118.6	115.6	112	105.5	99.1	93.7	88.5	82.4	76.2
50	SEL	8560	103.6	99.5	96.6	93.5	88.1	81.7	77	71.6	65.5	58.9
50	SEL	14000	105.1	100.9	97.8	94.3	88.7	82.3	77.6	72.4	66.4	59.9
50	SEL	24370	108.1	103.9	100.9	97.5	92.1	86	81.5	76.5	70.7	64.4
50	SEL	34850	111.8	107.9	105	101.9	96.7	90.5	86.1	80.9	75.1	68.8
50	SEL	40240	114.3	110.4	107.6	104.5	99.4	93.2	88.7	83.5	77.7	71.4
50	SEL	44940	117.1	113.2	110.4	107.2	102.1	96	91.4	86.3	80.4	74.1
51	EPNL	7000	104.4	99.5	95.8	91.6	84.1	76.3	71.1	65.8	60.3	55.1
51	EPNL	12000	106.5	101.5	97.7	93.5	85.7	78.1	73	67.9	62.6	57.6
51	EPNL	17000	107.1	102.5	99.1	94.5	86.9	79.5	75.3	69.5	64	58.4
51	EPNL	25000	107.4	102.9	99.5	95.9	89.2	82.2	77.4	71.8	65.9	59.8
51	EPNL	33000	107.7	103.7	100.7	97.1	91.8	85.5	80.7	75.2	69	62.6
51	EPNL	41000	111.6	107.8	105	102.1	96.9	90.6	85.8	80.3	74.1	67.7
51	SEL	7000	98.9	94.1	90.8	87.3	81.6	75.2	70.4	65	58.6	52
51	SEL	12000	101.7	96.7	93.2	89.4	83.3	76.6	71.7	66.2	60	53.4
51	SEL	17000	103	98.2	94.8	90.8	84.4	77.5	72.7	67.3	61.2	54.7
51	SEL	25000	104.2	99.5	95.9	92	85.6	79	74.5	69.6	63.9	57.9
51	SEL	33000	105.4	101.1	97.9	94.5	89	83.1	78.6	73.7	68	61.9
51	SEL	41000	107.4	103.4	100.7	97.5	92.6	86.7	82.3	77.4	71.7	65.7
52	EPNL	5000	98.6	93.3	89.1	84.1	77.5	70.1	64.3	57.6	50.1	42.1
52	EPNL	12000	100.2	95.5	91.8	86.2	79.7	72.5	67	60.8	53.9	46.7
52	EPNL	13000	99.8	94.8	91.4	87.4	81.3	74.4	68.9	62.7	55.6	48.2
52	EPNL	18000	103.8	98.7	95.3	91.4	85.4	78.6	73.3	67.4	60.8	53.9

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
52	EPNL	30000	108.7	103.8	100.5	97	91.4	84.9	79.8	74.1	67.6	60.9
52	EPNL	36000	111.1	106.7	103.5	100.4	95.7	89.3	84.3	78.6	72.1	65.3
52	SEL	5000	94.4	89.6	86.4	83.1	77.8	71.2	66.2	60.4	54.1	47.4
52	SEL	12000	97	92.2	89	85.6	80.2	73.7	69	63.6	57.4	50.9
52	SEL	13000	94.2	90.4	87.5	84.3	78.9	72.6	67.8	62.5	56.5	50.1
52	SEL	18000	97.9	94.1	91.2	87.9	82.5	76.3	71.8	66.5	60.7	54.5
52	SEL	30000	102.8	99.3	96.6	93.7	88.9	82.9	78.3	73.1	67.2	61
52	SEL	36000	104.8	101.8	99.7	97.2	93	87.1	82.3	76.9	70.7	64.3
53	EPNL	5000	99.3	94.4	90.9	86.6	79.2	71.6	65.9	59.2	51.8	44
53	EPNL	12000	104.4	100	96.5	91.8	83.6	74.2	68.3	61.9	55.6	49.5
53	EPNL	13000	102.9	98.5	95.6	91.6	84.8	76.4	70.1	63.7	56.6	49.5
53	EPNL	24000	109.4	104.8	101.8	97.8	90.8	82.1	76.2	70.6	64.7	59.4
53	EPNL	30000	110.8	106.1	103	99.6	93.2	84.8	79.2	73.5	67.7	62.2
53	EPNL	36000	111.5	106.6	103.6	101.2	95.9	88	83	76.7	70.4	64
53	SEL	5000	95.1	90.8	87.7	84.3	78.7	72	66.8	61.1	54.7	48.2
53	SEL	12000	99.6	95	91.7	88.1	82.1	75.2	69.9	63.9	57.2	50.4
53	SEL	13000	97.4	93.3	90.2	86.8	80.9	73.9	68.6	62.5	55.8	48.8
53	SEL	24000	101.5	97.2	94	90.4	84.7	77.9	73.2	68.2	62.7	57
53	SEL	30000	103.3	99.6	96.7	93.6	88.3	81.9	77.1	71.9	66	59.9
53	SEL	36000	105.5	102.5	100.2	97.7	93.3	87.3	82.3	76.5	69.7	62.6
54	EPNL	4000	94.8	90.5	87.3	83.6	77.8	69.7	63.7	57.4	48.7	36.4
54	EPNL	6000	97.5	93.4	90	86.6	81	72.8	67	61.1	53	42.2
54	EPNL	7000	100.4	95.8	92.6	89.3	84	75.6	70.4	64.8	57.8	48.8
54	EPNL	10000	103.5	99.5	96.5	93.2	88	81	76	70.1	63.3	54.6
54	EPNL	13000	106.3	102.5	99.8	96.5	91.5	84.9	79.9	74.2	67.4	59.2
54	EPNL	19000	113.1	109.3	106.4	103.1	98.2	91	85.8	80.4	73.6	65.5
54	SEL	4000	90.5	87	84.5	81.7	77	71	66.3	60.9	54.5	47.4

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
54	SEL	6000	93.7	89.6	87.3	84.5	79.8	73.9	69	63.8	57.3	50
54	SEL	7000	95.6	92	89.5	86.6	82.3	76.4	71.9	66.7	60.4	53.5
54	SEL	10000	100.5	97	94.4	91.7	86.8	81	76.4	70.8	64.7	57.8
54	SEL	13000	104.4	100.8	98.1	95.5	90.5	84.5	79.8	74.5	68.1	61.1
54	SEL	19000	110.5	106.8	104.1	101.5	96.7	90.7	85.9	80.4	74	67
55	EPNL	2600	107.8	103.2	99.5	95.1	88.7	80.1	73.8	68.1	61.4	53.4
55	EPNL	2800	111.1	106.2	102.4	97.9	91.1	83.3	76.6	70.7	63.8	56.1
55	EPNL	3200	110	105.5	102.1	98.1	91.6	84.4	79.3	73.6	66.9	59.4
55	EPNL	3400	110.9	106.6	103.4	99.7	93.9	87.2	82.4	76.9	70.6	63.4
55	EPNL	3600	112.1	108.2	105.2	101.9	96.5	90.4	85.9	80.8	74.6	67.6
55	EPNL	3900	114.5	111.2	108.7	105.9	101	96.2	92.1	87.3	79	74.4
55	SEL	2600	101.9	97.5	94.4	91	85.6	79.6	74.7	69.3	62.8	56.4
55	SEL	2800	104.3	99.6	96.2	92.6	87.2	81	76.2	70.8	64.6	58
55	SEL	3200	104.5	100.2	97.4	94.2	89	83	78.5	73.4	67.5	61.1
55	SEL	3400	106	102	99.3	96.3	91.4	85.6	81.2	76.1	70.3	64.1
55	SEL	3600	107.8	104.1	101.5	98.7	94.1	88.4	84.2	79.2	73.5	67.4
55	SEL	3900	111.2	107.9	105.4	102.8	98.6	93.4	89.2	84.4	78.8	72.9
56	EPNL	1798	101.8	96.5	92.4	88.1	80.4	73.4	68.5	63.1	57	50.8
56	EPNL	2698	102.6	97.8	93.9	90.1	83.5	76.9	71.9	66.4	60.2	53.8
56	EPNL	3147	105.6	100.5	96.5	92.2	85.4	78.6	73.6	68.1	61.9	55.5
56	EPNL	3597	106.4	101.1	97.1	93.1	86.9	80.3	75.3	69.8	63.6	57.2
56	EPNL	4496	107.3	102.3	98.9	95.6	90.2	83.7	78.8	73.2	66.8	60.1
56	EPNL	10116	124.5	119.8	116.6	113.3	108.1	102.6	98.7	94	88.1	81
56	SEL	1798	96.5	91.7	88.2	84.8	78.8	72.6	68.1	62.3	55.4	47.9
56	SEL	2698	97.4	93.2	90.1	87	81.8	75.8	71.3	65.5	58.5	50.9
56	SEL	3147	99.9	95.4	92	88.8	83.7	77.4	72.9	67.1	60.2	52.8
56	SEL	3597	100.5	96.3	92.9	89.8	85.1	79	74.5	68.7	61.8	54.3

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
56	SEL	4496	102.2	98.4	95.7	92.6	88.3	82.2	77.7	71.9	65	57.5
56	SEL	10116	121.6	117.5	114.5	111.4	106.4	101.1	96.9	91.8	84.9	76
57	EPNL	1798	100.3	95.3	91.5	87.1	80	73	68.1	62.7	56.7	50.6
57	EPNL	2698	100.3	96	92.9	88.9	82.5	76	71	65.6	59.4	53
57	EPNL	3147	104	99.3	95.9	91.5	84.3	77.4	72.5	67.1	61.2	55.1
57	EPNL	3597	104.4	100.2	96.8	92.3	85.5	78.9	74	68.5	62.3	55.9
57	EPNL	4496	105	101.2	98.4	94.6	88.6	81.8	76.9	71.5	65.4	59.2
57	EPNL	10116	121.7	116.4	112.8	109.2	103.4	97.4	93.2	88.3	82.1	74.7
57	SEL	1798	95.5	91	87.9	84.5	78.6	72.4	67.6	61.4	53.9	45.6
57	SEL	2698	95.8	92	89.4	86.7	81.5	75.3	70.4	64.2	56.7	48.5
57	SEL	3147	98.8	94.6	91.5	88.5	83.2	76.7	71.9	65.7	58.4	50.4
57	SEL	3597	99.6	95.6	92.8	89.7	84.4	78.2	73.3	67.1	59.8	51.7
57	SEL	4496	101.7	97.9	95.2	92.5	87.3	81.1	76.2	70	62.6	54.4
57	SEL	10116	118.1	113.7	110.5	107.3	102	96.2	91.8	86.3	79	69.5
58	EPNL	35	91.8	86.9	83	78.4	71.4	61.4	54.8	48.4	40.9	33.7
58	EPNL	40	95.3	90.4	86.5	81.9	74.9	64.9	58.3	51.9	44.8	37.9
58	EPNL	80	93.7	89	85.9	82.1	76.1	69.8	64.8	59.2	52.9	46.5
58	EPNL	100	95.9	91.2	88.1	84.3	78.4	72	67	61.4	55.1	48.7
58	SEL	35	85.7	82.3	79.6	76	70.2	63.6	58.9	53.5	47.9	42.2
58	SEL	40	89.2	85.8	83.1	79.6	73.7	67.3	62.4	57	50.9	44.7
58	SEL	80	86.5	82.6	80	77	72	65.8	61.5	56.2	50.5	44.4
58	SEL	100	88.7	84.8	82.2	79.2	74.2	68	63.6	58.4	52.9	47.3
59	EPNL	35	93.8	89.7	86.7	83.4	76.8	68.2	62.5	57.3	51.5	46.3
59	EPNL	40	97.5	93.4	90.4	86.9	81.2	74.7	70	64.5	58.5	52.3
59	EPNL	90	90.9	87.4	84.9	81.9	77	71.4	67.2	62.2	56.6	50.7
59	EPNL	100	94.5	91.1	88.9	85.9	81.3	76.4	72.6	68.4	63.8	59.1
59	SEL	35	88.9	84.4	81.1	77.7	71.9	65.8	62.3	58.7	55.6	52.8

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
59	SEL	40	91.8	87.8	84.8	81.5	76.2	70.8	67.4	63.7	59.9	56.1
59	SEL	90	84.6	81	78.5	75.9	72.3	68.1	65.2	62.2	58.8	55.6
59	SEL	100	87	83.5	81.4	79.1	75.4	71.5	68.7	65.9	62.7	59.6
60	EPNL	7000	104.4	99.5	95.8	91.6	84.1	76.3	71.1	65.8	60.3	55.1
60	EPNL	12000	106.5	101.5	97.7	93.5	85.7	78.1	73	67.9	62.6	57.6
60	EPNL	17000	107.1	102.5	99.1	94.5	86.9	79.5	75.3	69.5	64	58.4
60	EPNL	25000	107.4	102.9	99.5	95.9	89.2	82.2	77.4	71.8	65.9	59.8
60	EPNL	33000	107.7	103.7	100.7	97.1	91.8	85.5	80.7	75.2	69	62.6
60	EPNL	41000	111.6	107.8	105	102.1	96.9	90.6	85.8	80.3	74.1	67.7
60	SEL	7000	98.1	93.9	90.8	87.4	81.4	75	70.3	65.7	60.6	55.7
60	SEL	12000	99.3	95	91.9	88.5	82.5	76.2	71.7	67.2	62.3	57.6
60	SEL	17000	100	95.6	92.6	89.3	83.7	77.6	73.1	68.5	63.4	58.4
60	SEL	25000	100.3	96.7	93.9	90.9	85.9	79.8	75.4	70.5	65.2	59.8
60	SEL	33000	103.3	99.9	97.3	94.5	89.7	83.6	79.2	74.3	69	63.5
60	SEL	41000	106.2	103.1	100.8	98.2	93.6	87.6	83.1	78.1	72.5	66.8
61	EPNL	3690	103.9	99.1	95.5	91.3	83.9	75.8	69.6	62.5	54.5	46.1
61	EPNL	6180	107.5	102.9	99.5	95.4	88.3	80.4	74.3	67.2	59.3	51
61	EPNL	9880	106.9	102.3	98.8	94.6	87.9	80.7	74.8	68.2	60.5	52.4
61	EPNL	13190	106.2	102	98.9	95.4	89.9	83.2	77.9	71.7	64.6	57.2
61	EPNL	17273	107.5	103.7	101	98.2	93.5	87.2	82.2	76.5	69.9	63
61	EPNL	21180	114.9	111.2	108.4	105.3	99.9	93.4	88.4	82.6	76.1	69.2
61	SEL	3690	99.2	94.7	91.5	88	82.6	76	70.9	64.9	58	50.8
61	SEL	6180	101.3	96.9	93.6	90.3	85	78.7	73.8	68	61.2	54
61	SEL	9880	100.6	96.6	93.7	90.6	85.7	79.8	75.1	69.5	63	56
61	SEL	13190	102.8	98.9	96.1	93.2	88.4	82.6	78	72.5	66.1	59.3
61	SEL	17273	105.8	102.1	99.5	96.7	92.1	86.4	81.9	76.7	70.4	63.7
61	SEL	21180	109.6	106.3	103.9	101.4	97	91.5	87.1	81.9	75.7	69.2

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
62	EPNL	3000	100.2	95.3	91.6	87.2	79.4	72	66.4	60.3	53.4	44.4
62	EPNL	5000	102.8	97.9	94.2	89.8	82	74.6	69	62.9	56	47
62	EPNL	7000	109.3	104.4	100.6	96.2	87.9	80.3	74.7	68.4	61	51.5
62	EPNL	10000	114.9	109.9	106.1	101.6	94.9	87.6	82.1	75.9	68.6	59.8
62	EPNL	12000	118.1	113.1	109.3	104.9	98.7	91.6	86.2	80.4	73.6	65.3
62	EPNL	14000	121.1	116.2	112.4	108.5	102.4	95.5	90.4	84.7	78	69.8
62	SEL	3000	96.9	92.4	89.6	85.5	79.6	72.9	67.8	62.1	55.7	48.4
62	SEL	5000	99.9	95.4	92.1	88.5	82.6	75.9	70.8	65.1	58.7	51.4
62	SEL	7000	105.7	101.1	97.8	94.2	88.2	81.3	76	69.9	63	55.2
62	SEL	10000	110.9	106.3	103	99.4	93.4	86.5	81.4	75.7	69.4	62
62	SEL	12000	113.7	109.3	106	102.6	96.9	90.4	85.5	80	73.5	65.9
62	SEL	14000	116.4	112	108.8	105.4	99.8	93.5	88.6	83.2	77	69.7
63	EPNL	3000	101.9	96.8	93	88.5	81.8	74.4	68.9	62.5	54.6	43.4
63	EPNL	5000	104.8	99.9	96.2	92.1	86	78.9	73.7	67.6	60.3	50.6
63	EPNL	7000	110.6	105.7	101.9	97.5	89.2	81.6	76	69.7	62.3	52.8
63	EPNL	10000	115.1	110.1	106.4	102.1	95.4	88.2	82.8	76.9	70.2	62.1
63	EPNL	12000	117.6	112.6	109.2	105.6	99.7	93.2	88.5	83.3	76.8	69
63	EPNL	14000	121.3	116.7	113.4	109.8	104	97.6	93.1	88	81.9	74.5
63	SEL	3000	98.2	93.4	90.1	86.5	80.8	74.4	69.5	63.9	57.5	50
63	SEL	5000	99.8	95.4	92.3	89	83.5	77.2	72.5	67.1	60.8	53.6
63	SEL	7000	106.5	101.9	98.6	95	89	82.1	76.8	70.7	63.8	56
63	SEL	10000	111	106.4	103.1	99.6	93.7	86.9	81.8	76.2	69.8	62.7
63	SEL	12000	113.9	109.4	106.2	102.8	97.2	91.1	86.6	81.6	76	69.5
63	SEL	14000	117.3	112.8	109.7	106.3	100.9	94.9	90.5	85.8	80.4	74.2
64	EPNL	4496	99.5	95.2	91.9	88	81.8	73.1	67.9	62.3	56.5	51.6
64	EPNL	13489	110.8	106.7	103.8	100.3	94.4	88.5	84.6	80.3	75.8	72.1
64	SEL	4496	93.3	89.4	86.6	83.3	78.2	72	67.7	62.9	57.9	53.7

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
64	SEL	13489	108	104.3	101.7	98.7	93.9	88.2	83.7	78.5	72.9	68.3
65	EPNL	4496	99.9	95.5	92.3	88	81.3	72.3	67.3	61.8	56.1	51.3
65	EPNL	13488	109.3	105.3	102.4	99.2	93.6	88.2	84.5	80.5	76.3	72.8
65	SEL	4496	93.1	88.9	85.8	82.2	76.8	70.4	66.4	62.1	57.6	53.8
65	SEL	13488	106.5	102.9	100.2	97.4	92.7	87.3	83.2	78.5	73.6	69.5
66	EPNL	8992	109.3	103.9	99.8	94.7	84.8	72.5	64.2	55.8	47.2	40
66	EPNL	15737	110.8	106	102.2	97.7	89.5	79.5	73.4	67.3	61	55.8
66	EPNL	20233	112.1	107.4	104.1	99.7	92.3	83.6	77.7	71.8	65.6	60.7
66	SEL	8992	104.1	99	95.1	89.9	81.5	73.7	67.3	60.3	53.1	47.1
66	SEL	15737	106.5	101.4	98	93.7	85.9	78.3	72.5	66	59.5	54
66	SEL	20233	107.8	103	99.7	96	88.7	81.3	75.5	69	62.5	57
67	EPNL	8000	105.9	100.8	97.2	93.4	87	79.6	73.9	68.1	62.2	56.6
67	EPNL	16000	110.3	105.6	101.8	97	89	81	75.6	70	64.4	59
67	EPNL	26000	112.5	108.2	104.8	100.8	93.6	86	80.9	74.5	68.1	61.9
67	EPNL	32000	113.3	109.3	106	102.3	95.8	88.4	83.2	76.9	70.5	64.4
67	EPNL	40000	114.7	110.8	107.7	104.3	98.6	91.8	86.7	80.7	74.6	68.8
67	EPNL	46000	116.3	112.4	109.4	106.1	100.7	94.6	89.9	84.2	78.5	73
67	SEL	8000	103.6	99.1	95.8	92.3	86.6	80.1	75.3	70.5	65.6	60.9
67	SEL	16000	105.5	100.7	97.1	93.3	87.2	80.6	76	71.2	66.4	61.8
67	SEL	26000	106.3	102	98.6	95	89	82.8	78.5	73.8	69.1	64.7
67	SEL	32000	107.4	103.3	100.1	96.7	91	84.9	80.7	76.1	71.5	67.1
67	SEL	40000	109	105.2	102.3	99.2	94	88.2	84.1	79.7	75.1	70.8
67	SEL	46000	111.1	107.4	104.6	101.7	96.7	91.3	87.3	82.9	78.5	74.2
68	EPNL	10020	101.6	97	93	89	82.1	75.5	70.1	64.3	58.1	52.3
68	EPNL	23190	110.9	106	102.2	98.7	90.1	81.7	75.7	69.3	62.5	55.9
68	EPNL	25940	110.7	104.2	100.2	96.2	89.5	81.2	75.2	68.4	61.2	54.2
68	EPNL	39180	112.2	106.7	103.2	99.5	93.2	86.2	80.7	74.2	67.2	60.2

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
68	EPNL	51530	114.7	110.2	107.2	104.2	98.7	92.4	88	82	75.2	68.5
68	EPNL	55500	117.2	112.7	110	107.2	101.8	96.2	91.7	86.7	80.2	73.7
68	SEL	10020	99.5	95.1	91.4	88.3	82.5	76.3	71.9	66.6	61.3	56.3
68	SEL	23190	105.1	100.6	97.1	93.7	87	80.1	75.1	69.5	64	58.4
68	SEL	25940	103.7	98.7	95.4	92.2	87	80.7	76	70.2	64	55.2
68	SEL	39180	106	101.7	98.7	96.2	91.2	85.2	80.2	75	68.7	60.2
68	SEL	51530	110.2	106.2	103.4	100.7	96.2	90.7	86.2	81.2	75.2	67.2
68	SEL	55500	113.2	109.2	106.4	103.7	98.2	94.2	89.7	85.2	79.2	72
69	EPNL	9300	105.6	101.1	97.1	93.1	85.7	75.9	73.1	67.1	61.1	55.1
69	EPNL	22400	110.6	105.9	101.7	97.4	89.4	81	75.5	69	62.6	56.9
69	EPNL	24960	111.2	104.7	100.4	96.2	89.2	80.5	74.3	68.2	60.2	53.2
69	EPNL	37100	112.2	106.9	103.2	99.7	93.2	85.7	80.2	74.2	66.2	59.2
69	EPNL	49010	114.2	109.2	106.5	103.2	97.6	91	85.7	80.2	73	66.2
69	EPNL	53830	116.2	111.5	108.3	105.2	99.8	93.7	88.4	83.2	76.5	70.2
69	SEL	9300	101	96.9	93	89.6	83.6	77.7	73	68.1	63.1	58.4
69	SEL	22400	104.3	99.7	96.1	92.1	85.8	79.3	74.6	69.7	64.6	59.7
69	SEL	24960	103.7	98.2	94.7	91.2	85.7	79.4	74.7	69.7	63.7	58
69	SEL	37100	106.2	101.2	98	94.7	89.7	83.7	79.2	74	68.2	62.7
69	SEL	49010	109.2	105	102	99.1	94.2	88.7	84.2	79.3	73.2	68.2
69	SEL	53830	111.4	107.3	104.2	101.2	96.8	91.2	87.2	82	76.2	71.2
70	EPNL	82	106.7	102	98.6	95.1	89.3	82.7	77.5	71.8	65.2	57.5
70	EPNL	85	112.9	108.3	105	101.5	95.8	89	83.5	77.3	70.3	62
70	EPNL	90	124.8	120	116.3	112.2	105.9	98.2	91.9	84.7	76.4	66.4
70	SEL	82	103	98.7	95.7	92.6	87.5	81.6	77.1	72	66.2	59.7
70	SEL	85	109.9	105.6	102.7	99.5	94.3	88.1	83.3	77.8	71.5	64.2
70	SEL	90	121.2	116.6	113.4	110.1	104.6	98	92.7	86.3	78.2	68.2
71	EPNL	87	104.5	99.8	96.4	92.5	86	78.9	73.3	67	59.4	49.1

Table G-1. Aircraft Decibel Level By Thrust And Distance (Continued)

NOISE_NUM	METRIC	THRUST	DB 200FT	DB 400FT	DB 630FT	DB 1000FT	DB 2000FT	DB 4000FT	DB 6300FT	DB 10000FT	DB 16000FT	DB 25000FT
71	EPNL	97	122.9	117.7	113.8	109.4	103	95.8	90.4	84.2	77.2	68.6
71	EPNL	104	130.4	125.2	121.2	116.7	109.3	101.9	96.5	90.7	83.9	75.7
71	SEL	87	99.6	95.3	92.3	89	83.6	77.1	72.1	66.5	60.1	52.8
71	SEL	97	118.7	114.1	110.8	107.3	101.6	95	90	84.3	77.6	69.9
71	SEL	104	126.1	121.1	117.6	114	108.1	101.3	96.2	90.4	83.9	76.2
72	EPNL	83	109.4	105	101.8	98.5	93.1	86.6	81.6	75.9	69.3	61.5
72	EPNL	86	118.8	114.2	110.9	107.1	100.9	94	88.7	82.7	75.9	67.7
72	EPNL	91	125.7	120.8	117.2	113.1	106.1	99	93.7	87.9	81.1	73
72	SEL	83	106.3	102.2	99.3	96.2	91.1	85.1	80.5	75.3	69.3	62.4
72	SEL	86	116.1	111.8	108.7	105.5	100.1	93.6	88.7	83.1	76.8	69.4
72	SEL	91	121.9	117.4	114.3	110.8	105.2	98.5	93.5	87.8	81.3	73.9
73	EPNL	84	106.2	101.6	98.4	94.7	88.4	81.4	76	69.9	62.8	53.6
73	EPNL	89	128.3	123.4	119.8	115.7	109.3	102.3	97.1	91.4	84.6	76.5
73	EPNL	93	130.5	125.5	121.8	117.6	110.6	103.4	98	92.1	85.4	77.3
73	SEL	84	102.5	98.3	95.3	92.1	86.8	80.4	75.5	69.8	63.4	56.2
73	SEL	89	124.6	120.1	116.9	113.6	108.1	101.7	96.8	91.2	84.8	77.3
73	SEL	93	126.2	121.5	118.2	114.7	109	102.4	97.4	91.8	85.3	77.7

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13. ABSTRACT *(Maximum 200 words)*
To meet its objective of assisting the U.S. aviation industry with the technological challenges of the future, NASA must identify research areas that have the greatest potential for improving the operation of the air transportation system. To accomplish this, NASA is building an Aviation System Analysis Capability (ASAC).
The Noise Impact Model (NIM) has been developed as part of the ASAC. Its primary purpose is to enable users to examine the impact that quieter aircraft technologies and/or operations might have on community noise impact and air carrier operating efficiency at any of 16 large- and medium-sized U.S. airports. The analyst chooses an airport and case year for study, selects a runway use configuration and set of flight tracks for the scenario, and has the option of reducing the noise of the aircraft that operate at the airport by 3, 6, or 10 decibels. NIM computes the resultant noise impact and estimates any airline operational improvements. Community noise impact is characterized in three ways: the size of the noise contour footprint, the number of people living within the contours, and the number of homes located in the same contours. Distance and time savings are calculated by comparing the noise abatement flight path length to a less circuitous alternate routing. For a more efficient runway use configuration, the increase in capacity and reduction in delay are shown.

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